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REPORTS

FROM

COMMISSIONERS, INSPECTORS,

AND OTHERS:

THIRTY-FIVE VOLUMES.

— *(5.)* —

EXPLOSIONS.

Session

12 *March* 1894 —— 25 *August* 1894.

VOL. XX.

1894.

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THIRTY-FIVE VOLUMES:—CONTENTS OF THE

FIFTH VOLUME.

N.B.—*THE* Figures *at the* beginning of the line, *correspond with the* N° *at the foot of each* Report; *and the* Figures *at the* end of the line, *refer to the* MS. Paging *of the Volumes arranged for The House of Commons.*

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FROM

COMMISSIONERS, INSPECTORS,

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1891.

THIRTY-FIFTH VOLUME.—CONTENTS OF THE

FIFTH VOLUME.

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REPORT

TO THE

SECRETARY OF THE BOARD OF TRADE

UPON THE

WORKING OF THE BOILER EXPLOSIONS ACTS, 1882 AND 1890,

WITH

APPENDICES.

(*In continuation of Parliamentary Paper* C.—7081.)

Presented to both Houses of Parliament by Command of Her Majesty.

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1894.

[C.—7489.] *Price* 2½*d.*

Report on the Working of the Boiler Explosions Acts, 1882 and 1890, during the year 1893–94.

TWELFTH REPORT.

TO THE SECRETARY OF THE BOARD OF TRADE.

Preliminary inquiries or formal investigations under the provisions of the Boiler Explosions Acts, 1882 and 1890, were held in 104 cases during the 12 months ended 30th June 1894. This is the largest number of explosions dealt with during any similar period since the Act of 1882 came into force, although the loss of life is below the annual average, 24 persons having been killed and 54 injured.

Twenty-three formal investigations were ordered in the course of the year, the cases selected for the fuller inquiry being those in which there was *primâ facie* evidence of neglect in the supervision or management of the boiler. The following summary shows the general finding of the Courts appointed :—

Report No.	General finding of Court.	Order as to Costs.
667	Owner blamed for neglect	Owner to pay 30*l.* costs.
671	User blamed for neglect	User to pay 5*l.* costs.
676	Owners held responsible for the neglect of their chairman and engineer.	Owners to pay 50*l.* costs.
678	Owner blamed for neglect	Owner to pay 15*l.* costs.
685	Owners blamed for neglect	Owners to pay 60*l.* costs.
686	No blame attached to any person in respect to the explosion.	No order as to costs.
688	Owners (2) blamed for neglect, and a person who ignorantly undertook inspection of boiler also blamed.	Owners to pay 40*l.* each and the inspector 10*l.* costs.
695	Owner, who was killed, was blamed for working boiler at too high a pressure.	No order as to costs.
703	Owner blamed for neglect	Owner to pay 15*l.* costs.
704	Person who fitted the apparatus blamed	No order as to costs.
710	Locomotive foreman blamed for lax discipline	Foreman to pay 5*l.* costs.
713	Contractor and sub-contractors who supplied the apparatus blamed.	Three contractors to pay 5*l.*, 10*l.*, and 20*l.* costs respectively.
719	Owner blamed for neglect	Owner to pay 15*l.* costs.
730	Owner blamed for neglect	Owner to pay 15*l.* costs.
732	Owners blamed for working boiler at an unsafe pressure	Owners to pay 35*l.* costs.
735	Owners blamed somewhat for not employing a skilled chemist.	No order as to costs.
739	Engineer who supplied the fitting blamed	Engineer to pay 30*l.* costs.
740	Superintending and chief engineers employed by owners blamed.	No order as to costs.
747	Owners held responsible for negligence of their engine-wright, and boiler-maker who sold boiler to them blamed.	Owners to pay 30*l.* and the boiler-maker 10*l.* costs.
748	Owners held responsible for their boiler-maker's neglect	Owners to pay 10*l.* costs.
752	Owners seriously blamed for negligence	Owners to pay 40*l.* costs.
759	Attendant blamed for neglect	No order as to costs.
762	Owner blamed for neglect	Owner to pay 10*l.* costs.

It is to be regretted that, notwithstanding the formal investigations held in this and past years, there has been an increase in the total number of explosions (many, however, being of a trivial nature), chiefly among marine boilers, and in boilers used for heating purposes in churches, chapels, schools, &c. In the latter class there were

21 explosions during the four days, January 5, 6, 7, and 8, due to the freezing of the water in some portion of the circulating pipes, and to the want of caution shown by the attendants in re-lighting the fires before ascertaining whether any obstruction had been caused by ice. As a matter of general interest it may be well to remind those who are responsible for the management of public buildings which are heated by any kind of water apparatus—and more especially those which are not in constant use—that unless precautions are taken there is a standing risk of ice forming in the pipes during severe frost. It is advisable that, in such cases, the boilers should be fitted with efficient means for preventing undue pressure, but in the absence of any such fitting the temperature of the water, if any, in the boiler or connections should not be allowed to fall to the freezing point.

Appendices are attached showing particulars of the cases dealt with, the descriptions of boilers which failed, the annual loss of life from boiler explosions since the Boiler Explosions Acts came into operation, and a Report from the Board's Solicitor on the formal investigations held.

INGRAM B. WALKER,
Assistant Secretary.

Board of Trade,
Marine Department,
November 1894.

APPENDIX A.

Boiler Explosions Acts, 1882 and 1890.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894.

No. of Report, Place of Explosion, and Owner of Boiler.	Date of Explosion.	Persons killed.	Persons injured.	General Description and age of Boiler or Vessel which exploded.	Part of the Boiler which gave way.	Purpose for which Boiler was used.	Whether inspected or insured by any Company or Association, &c.	Cause of Explosion.	General finding of Court if a Formal Investigation held.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
660.									
"Morag Glen," S.S., O.N. 99,863; Messrs. J. G. Frew & Co.	11 Aug. 1893	—	—	Vertical, with cross water-tubes. 1 year.	One of the cross tubes -	Propelling the vessel.	Not inspected by any company or association.	Over-heating consequent on accumulation of dirt and scale.	Preliminary inquiry only.
661.									
"Eagle," Steam Launch; Mr. J. W. Johnson.	18 July 1893	—	1	Vertical cylindrical - Age not ascertained.	Firebox and uptake -	Do.	Not inspected or insured by any company or association.	Wasting of the firebox and uptake.	Do.
662.									
Brettell Lane, Worcestershire, Dudley and Stourbridge Steam Tramways Co., Ltd.	28 July 1893	—	1	Locomotive - - 2 years.	One of the brass tubes -	Working tram-engine.	Do. - - -	Wasting of the tube -	Do.
663.									
"W. S. Caine," S.S., O.N. 87,232; Messrs. W. Thomas & Co.	17 July 1893	—	—	Cylindrical multi-tubular. 10 years.	Bottom of shell - -	Propelling the vessel.	Lloyd's - - -	External corrosion and internal grooving.	Do.
664.									
Blackburn (Craven's Brow); Blackburn and Over Darwen Tramways Co.	12 July 1893	1	—	Main steam pipe - 6 years.	Pipe at bend near smoke-box.	Conveying steam to tram engine.	Scottish Boiler Insurance Co.	Wasting from action of grit and heated gases.	Do.
665.									
"Argyll," S.S., O.N. 93,268; Messrs. J. Little & Co.	17 Aug. 1893	—	—	Cylindrical marine - 7 years.	One of the rivets in circumferential seam blown out.	Propelling the vessel.	Lloyd's - - -	Corrosion of head of rivet -	Do.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued.*

No. of Report, Place of Explosion, and Owner of Boiler. 1.	Date of Explosion. 2.	Persons killed. 3.	Persons injured. 4.	General Description and Age of Boiler or Vessel which exploded. 5.	Part of the Boiler which gave way. 6.	Purpose for which Boiler was used. 7.	Whether inspected or insured by any Company or Association, &c. 8.	Cause of Explosion. 9.	General finding of Court if a Formal Investigation held. 10.
666.									
Battersea, London; Messrs. Garton, Hill & Co.	9 Sept. 1893	1	—	Converting vat made of pine. 4 years.	Parts of two staves blown out.	The manufacture of glucose.	Not inspected or insured by any company or association.	Over-pressure - -	Preliminary inquiry only.
667.									
Netherton; Mr. J. Harrison.	14 Aug. 1893	—	—	Cylindrical, externally fired. Age not known.	Shell - - -	Working leather cutting machine.	Do. - - -	External corrosion of top of boiler.	Owner blamed for neglecting to have boiler inspected, and ordered to pay 30*l.* costs.
668.									
Ancoats; Executors of the late Mr. J. Lamb.	28 Sept. 1893	—	2	Expansion ring on steam-pipe. Age not known.	Side of ring - -	Driving machinery.	Do. - - -	Wasting from grooving - -	Preliminary inquiry only.
669.									
"Mollington" P.S., O.N. 86,168; Mr. J. Davies.	26 Aug. 1893	—	1	Multitubular, with annular superheater. 14 years.	Internal tube of superheater.	Propelling the vessel.	Board of Trade - -	Local corrosion - - -	Do.
670.									
"Solway Queen," S.S., O.N. 84,365; The Solway S.S. Co.	12 Sept. 1893	—	—	Cylindrical marine - 6 years.	Joint of bottom manhole door.	Do. -	Lloyd's - - -	Joint not carefully made; material used was of improper section.	Do.
671.									
Congleton; Mr. J. Booth (user).	24 Aug. 1893	—	2	Vertical - - Age not known.	Firebox - -	Working a fan.	Not inspected or insured by any Company or Association.	Wasting from corrosion, principally on fire-side.	User blamed for not making a sufficient examination of the boiler, and ordered to pay 5*l.* costs.
672.									
Belfast; Messrs R. Vickers (Ld.).	15 Sept. 1893	—	1	Lancashire - - 2 years.	Cast-iron manhole door -	Mill machinery.	Engine, Boiler, and Employers' Liability Insurance Co., Ltd.	Defects in the door - -	Preliminary inquiry only.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued.*

No. of Report, Place of Explosion, and Owner of Boiler. 1.	Date of Explosion. 2.	Persons killed. 3.	Persons injured. 4.	General Description and Age of Boiler or Vessel which exploded. 5.	Part of the Boiler which gave way. 6.	Purpose for which Boiler was used. 7.	Whether inspected or insured by any Company or Association, &c. 8.	Cause of Explosion. 9.	General finding of Court if a Formal Investigation held. 10.
673.									
Kirkstall, near Leeds; Leeds Tramway Co.	24 Oct. 1893	—	—	Locomotive - 9 years.	One of the tubes - -	Working a tramcar.	Yorkshire Boiler Insurance and Steam Users' Co., Ltd.	The wasting action of ashes and sulphurous fumes.	Preliminary inquiry only.
674.									
Guildhall, London; The Corporation of the City of London.	30 Oct. 1893	—	—	Tank boiler - 9 years.	Shell - - -	Heating the council chamber.	Not inspected or insured by any company or association.	Wasting of ends of stays -	Do.
675.									
Oldham; Bury, Rochdale and Oldham Tramway Co., Ltd.	18 Oct. 1893	1	—	Cylindrical vertical - 7 years.	Stay broken and portion blown out.	Working a tram-car.	Do. - -	Wasting of the stay and loosening of end in fire-box-plate.	Do.
676.									
Hindley; The Platt Lane Manufacturing Co.	4 Sept. 1893	1	—	Water tube type - 5 years.	One of the tubes - -	Working looms, &c.	National Boiler Insurance Co., Limited.	Over-heating through accumulation of deposit in headers.	The owners were held responsible for the neglience of their chairman and engineer, and were ordered to pay 50*l.* costs.
677.									
"Marion," S.S., O.N. 81,267; Dominion and Mississippi S.S. Co., Ltd.	12 Oct. 1893	—	—	Cylindrical multi-tubular. 7 years.	Lower part of back shell-plate.	Propelling the vessel.	Lloyd's - - -	Corrosion caused by leakage -	Preliminary inquiry only.
678.									
Nailsworth; Mr. E. A. Chamberlain.	18 Oct. 1893	—	—	Cylindrical pan - 4 years.	Top and internal fittings -	Boiling hemp, &c.	Not inspected or insured by any company or association.	Undue pressure - -	Owner blamed for injudicious management, and ordered to pay 15*l.* costs.
679.									
"Grinkle," S.S., O.N. 56,069; Palmer's Shipbuilding and Iron Co.	21 Nov. 1893	—	—	Cylindrical multi-tubular. 16 years.	Bottom of shell - -	Propelling the vessel.	Do. - -	Corrosion of the plate -	Preliminary inquiry only.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued.*

No. of Report, and Explosion, and Owner of Boiler.	Date of Explosion.	Persons killed.	Persons injured.	General Description and Age of Boiler or Vessel which exploded.	Part of the Boiler which gave way.	Purpose for which Boiler was used.	Whether inspected or insured by any Company or Association, &c.	Cause of Explosion.	General finding of Court if a Formal Investigation held.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
680.									
"European," S.S., O.N. 437; Messrs. W. & C. L. Ringrose.	19 Nov. 1893	1	1	Cylindrical multi-tubular. 3 years.	Joint of starboard man-hole door.	Propelling the vessel.	Board of Trade -	The use of material of unsuitable section.	Preliminary inquiry only.
681.									
Killinghall; Mr. J. S. Long and others.	6 Nov. 1893	—	1	Vertical multi-tubular. 18 years at least.	Fire box - - -	Farm purposes	Not inspected or insured by any company or association.	Corrosion of firebox plates -	Do.
682.									
Darcy Lever, near Bolton; Darcy Lever Coal Co	20 Nov. 1893	—	—	Vertical - - 17 years.	Crown of shell - -	Working winding engine and other purposes.	Do. - - -	Deterioration at root of flange due to deficiency of stays.	Do.
683.									
"Helvetia," S.S., O.N. 51,401; Messrs. Crow, Rudolf, & Co.	17 Nov. 1893	—	—	Cylindrical multi-tubular. 19 years.	One of the tubes - -	Propelling the vessel.	Do. - - -	Corrosion and wasting while vessel was laid up.	Do.
684.									
Little Hallam; Borough of Ilkeston.	26 Nov. 1893	—	—	Lancashire - - 6 years.	Crown of left furnace -	Working pumping machinery.	Boiler Insurance and Steam Power Company, Limited.	Over-heating consequent on shortness of water, caused by leakage.	Do.
685.									
Narborough; Enderly & Stony Stanton Granite Co.	25 Oct. 1893	1	5	Vertical - - 6 years.	Firebox - - -	Do.	Do. - - -	Undue pressure, safety-valve being over-loaded.	Owners blamed for negligence in management of boiler, and ordered to pay 60*l.* costs.
686.									
Bridge of Earn; Mr. J. Richmond.	23 Nov. 1893	—	—	Vertical - 7 years.	Firebox - - -	Threshing machine.	Not inspected or insured by any company or association.	Over-heating through shortness of water.	No blame attached to any of the parties in respect to the explosion.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued.*

No. of Report, Place of Explosion, and Owner of Boiler.	Date of Explosion.	Persons killed.	Persons injured.	General Description and Age of Boiler or Vessel which exploded.	Part of the Boiler which gave way.	Purpose for which Boiler was used.	Whether inspected or insured by any Company or Association, &c	Cause of Explosion.	General finding of Court if a Formal Investigation held.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
687.									
Beckton, E.; Gas Light and Coke Co.	21 Sept. 1893	—	2	Cylindrical still, made of steel. 1 year.	Angle-iron ring connecting bottom to shell.	Distilling tar oils.	Not inspected or insured by any company or association.	Over-pressure caused by the compression of the vapour within the still by steam-pump.	Preliminary inquiry only.
688.									
Platt Lane Colliery, Wigan; Messrs. W. and T. Latham, users of boiler.	13 Nov. 1893	—	—	Lancashire - - 30 years.	Shell at back end -	Winding engine.	Do. - -	Corrosion of the plates, the boiler being worn out.	Mr. W. Latham and Mr. T. Latham were blamed for negligence as regards the inspection and management of the boiler, and each was ordered to pay 40*l.* costs; and Mr. W. Thompson, who ignorantly undertook to inspect the boiler, was ordered to pay 10*l.* costs.
689.									
"Oberon," S.S., O. N. 98,166; The Howard S.S. Co., Ltd.	23 Nov. 1893	—	1	Cylindrical multitubular. 3 years.	One of the tubes - -	Propelling the vessel.	Lloyd's - -	Wasting from corrosion -	Preliminary inquiry only.
690.									
Warrington; Messrs. J. Fairclough and Sons.	1 Jan. 1894	—	—	Steam pipe, made of cast iron. 1 year.	Piece at bend near cylinders.	Working mill engine.	Not inspected or insured by any company or association.	Faulty casting - -	Do.
691.									
Glossop; Trustees of the Tabernacle Sunday School.	6 Jan. 1894	—	—	Saddle - - 1 year.	Firebox torn from shell -	Heating upper room of school.	Do. - -	Undue pressure, the water in pipes having become frozen.	Do.
692.									
Ilkeston; Deacons of Independent Chapel.	6 Jan. 1894	—	—	Vertical - - 2 years.	Return pipe forced from socket.	Heating a chapel.	Do. - - -	Do. - - -	Do.
693.									
Chelmarsh; Vicar and Wardens of St. Peter's Church.	6 Jan. 1894	—	—	"Small tube high-pressure" type 6 years.	Tube - - -	Heating church	Do. - - -	Passages blocked, probably by ice.	Do.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued*.

No. of Report. Place of Explosion, and Owner of Boiler.	Date of Explosion.	Persons killed.	Persons injured.	General Description and Age of Boiler or Vessel which exploded.	Part of the Boiler which gave way.	Purpose for which Boiler was used.	Whether inspected or insured by any Company or Association, &c.	Cause of Explosion.	General finding of Court if a Formal Investigation held.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
694.									
Millstone; Mrs. C. L. Starr.	18 Dec. 1893	—	—	Vertical, with 33 tubes Age not ascertained.	One of the tubes - -	Laundry purposes.	Not inspected or insured by any company or association.	Internal corrosion: explosion hastened by neglect of attendant in not seeing that there was sufficient water in the boiler.	Preliminary inquiry only.
695.									
Buckpool, Banffshire; Messrs. W. Adams and Son.	19 Dec. 1893	1	2	Cornish - Age not known but apparently old.	Shell - - -	Foundry purposes.	Do. - - -	Grooving - - -	The senior member of the firm, who was killed, was not found justified in using the boiler at so high a pressure, but no order was made as to costs.
696.									
"Upward," Smack; O.N. 92,933; Mr. I. Allen.	25 Nov. 1893	—	—	Vertical - 7 years.	Upper cross tube -	Working trawl gear.	Do. - - -	Pitting of the tube - -	Preliminary inquiry only.
697.									
Birmingham; Mr. E. Phillips.	2 Dec. 1893	2	1	Cornish - Age not known.	Flue - - -	Working engine.	Boiler Insurance and Steam Power Company, Limited.	Over-heating through shortness of water, the supply pipe having become frozen.	Do.
698.									
Pontypridd; Trustees of Carmel Baptist Chapel.	6 Jan. 1894	—	—	Double coil of piping 7 years.	Piping - - -	Heating chapel	Not inspected or insured by any company or association.	Undue pressure, the water in the pipes having become frozen.	Do.
699.									
Kidderminster; Committee of School of Science and Art.	5 Jan. 1894	—	1	Small tube high-pressure type. 9 years.	Do. - - -	Heating premises.	Do. - - -	Do.	Do.
700.									
Walthamstow; Walthamstow School Board.	8 Jan. 1893	—	—	Double coil of piping 10 years.	Do. - - -	Do.	Do. - - -	Do.	Do.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued.*

No. of Report, Place of Explosion, and Owner of Boiler.	Date of Explosion.	Persons killed.	Persons injured.	General Description and Age of Boiler or Vessel which exploded.	Part of the Boiler which gave way.	Purpose for which Boiler was used.	Whether inspected or insured by any Company or Association, &c.	Cause of Explosion.	General finding of Court if a Formal Investigation held.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
701.									
Selkirk Parish Church; the heritors of the parish.	6 Jan. 1894	—	—	Small tube high-pressure type. 13 years.	Piping - - -	Heating church	Not inspected or insured by any company or association.	Undue pressure the water in the pipes having become frozen.	Preliminary inquiry only.
702.									
Sutton, Macclesfield; Langley School Board.	5 Jan. 1894	—	—	Coils of piping - 14 years.	Do. - -	Heating school	Do. - - -	Do. - - -	Do.
703.									
Oldham; Mr James Lees	2 Jan. 1894	—	—	Lancashire - - 32 years.	Shell - - -	Driving mill machinery.	Do. - - -	External corrosion - -	Owner blamed for neglecting to have boiler properly inspected, and ordered to pay 15*l.* costs.
704.									
Adel, Leeds; Leeds Society for reforming Juvenile Offenders.	6 Jan. 1894	2	—	Saddle - - 9 years.	Firebox - -	Heating premises.	Do. - -	Undue pressure, the water in the pipes having become frozen.	The plumber who fitted the apparatus was found somewhat to blame for omitting to advise the managers of removal of certain cocks, but no order was made as to costs.
705.									
Philipstown, King's County, at St. Conleth's Reformatory School.	6 Jan. 1894	—	1	Saddle - - 6 years.	Both ends - -	Heating church	Do. - - -	Do. - - -	Preliminary inquiry only.
706.									
"Greencastle," Steam Trawler; O.N. 79,958; Mr. R. B. Stoker.	6 Jan. 1894	—	—	Cylindrical multitubular. 9 years.	Rivet blown out -	Propelling the vessel.	Do. - - -	Corrosion of head of rivet -	Do.
707.									
Theatre Royal, Darwen; Mr. J. P. Hardacre.	8 Jan. 1894	—	—		Piping in fire -	Heating theatre	Do. - -	Undue pressure, the water in the pipes having probably become frozen.	Do.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894.—*continued.*

No. of Report, Place of Explosion, and Owner of Boiler.	Date of Explosion.	Persons killed.	Persons injured.	General Description and Age of Boiler or Vessel which exploded.	Part of the Boiler which gave way.	Purpose for which Boiler was used.	Whether inspected or insured by any Company or Association, &c.	Cause of Explosion.	General finding of Court if a Formal Investigation held.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
708.									
Oldham; Trustees of United Methodist Free Church Schools.	6 Jan. 1894	—	—	Annular 8 years.	Inner tube	Heating school	Not inspected or insured by any company or association.	Undue pressure; outlet pipes choked by ice.	Preliminary inquiry only.
709.									
Everton, Liverpool; Managing Committee of St. Saviour's Church Schools.	7 Jan. 1894	—	—	Coils of piping 10 years.	Piping in fire	Do.	Do.	Do.	Do.
710.									
Wirral Railway Extension, Seacombe; Mr. T. W. Davies.	4 Dec. 1893	2	1	Locomotive 8 years.	Furnace crown	Drawing contractor's waggons.	Do.	Shortness of water, and consequent over-heating, due to neglect of attendant.	The locomotive foreman was blamed for not discharging the attendant for previous and similar acts of carelessness, and was ordered to pay 5*l.* costs.
711.									
Delph, Oldham; Trustees of the Wesleyan Chapel.	7 Jan. 1894	—	—	Coils of piping 15 years.	Piping in fire	Heating chapel	Do.	Undue pressure; the water in the pipes having probably become frozen.	Preliminary inquiry only.
712.									
Heywood, Lancashire; Mr. F. Dutson.	6 Jan. 1894	—	—	Tubulous heating apparatus. 1 year.	One of the tubes	Heating premises.	Do.	Undue pressure; water in the pipes having become frozen.	Do.
713.									
Sunderland; the Sunderland Steam Laundry and Carpet Beating Co.	15 Dec. 1893	—	1	Decoudun ironing machine. Cast-iron bed and roller. Nearly new.	Cast-iron bed	Laundry purposes.	Do.	Defective casting	The Company contracted with Mr. Kirkaldy, their superintending engineer, for the supply of the bed, Mr. Kirkaldy gave the order to Mr. Harper Twelvetrees, who again sublet to Mr. Jacob Bridge, and the latter employed Mr. J. Stubbs to make the casting. Mr. Kirkaldy was ordered to pay 5*l.*, Mr. Harper Twelvetrees 10*l.*, and Mr. J. Bridge 20*l.* costs.
714.									
Bridgnorth; Deacons of the Congregational Chapel.	5 Jan. 1894	—	2	Coils of piping 6 years.	Piping in fire	Heating lecture-room and school-rooms.	Do.	Undue pressure; water in pipes probably having become frozen.	Preliminary inquiry only.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued*.

No. of Report, Place of Explosion, and Owner of Boiler.	Date of Explosion.	Persons killed.	Persons injured.	General Description and Age of Boiler or Vessel which exploded.	Part of the Boiler which gave way.	Purpose for which Boiler was used.	Whether inspected or insured by any Company or Association, &c.	Cause of Explosion.	General finding of Court if a Formal Investigation held.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
715. Bridgnorth; Deacons of the Congregational Chapel.	6 Jan. 1894	—	—	Coils of piping - 6 years.	Piping in fire - -	Heating chapel and vestry.	Not inspected or insured by any company or association.	Undue pressure; water in pipes probably having become frozen.	Preliminary inquiry only.
716. "Eden," S.S., O.N. 81,503; Mr. R. Ropner.	21 Oct. 1893	—	2	Double-ended cylindrical multitubular. 14 years.	Rivet blown out -	Propelling the vessel.	Lloyd's - - -	Corrosion of head of rivet -	Do.
717. Quarter Collieries, Lanarkshire; Mr. C. Dunlop.	8 Feb. 1894	—	—	Lancashire - - Age not ascertained.	Right-hand flue - -	Winding, pumping, &c.	Scottish Boiler Insurance and Engine Inspection Co.	Over-heating through shortness of water, due to error of attendant.	Do.
718. "Urpeth," S.S., O.N. 95,523; Messrs. J. Fenwick & Son.	2 Jan. 1894	—	—	Main steam pipe made of copper. 6 years.	Pipe at flange near stop-valve.	Conveying steam to engines.	Lloyd's - - -	Stresses caused by vibration of cylinders, the pipe being too rigid.	Do.
719. Field Dalling, Norfolk; Mr. J. H. Pearson.	13 Feb. 1894	—	2	Vertical cylindrical - 22 years.	Firebox - -	Farm purposes	Not inspected or insured by any company or association.	Corrosion of firebox plates -	Owner blamed for neglecting to have boiler inspected, and ordered to pay 15*l.* costs.
720. Coton-in-the-Elms, near Burton-on-Trent; Vicar and Wardens of St. Mary's Church.	6 Jan. 1894	—	—	Saddle - - 6 years.	Furnace - - -	Heating church	Do. - - -	Undue pressure; water in pipes having become frozen.	Preliminary inquiry only.
721. High Barnet; Trustee-Steward of the Wesleyan Church.	6 Jan. 1894	—	—	Coil of piping - 3 years.	Piping in fire - -	Heating school-room.	Do. - - -	Do. - -	Do.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued.*

No. of Report, Place of Explosion, and Owner of Boiler.	Date of Explosion.	Persons killed.	Persons injured.	General Description and Age of Boiler or Vessel which exploded.	Part of the Boiler which gave way.	Purpose for which Boiler was used.	Whether inspected or insured by any Company or Association, &c.	Cause of Explosion.	General finding of Court if a Formal Investigation held.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
722. Battersea; The London School Board.	7 Jan. 1894	—	1	Rectangular steel box, with copper tubes. 1 year.	Back of boiler - -	Heating school-room.	Not inspected or insured by any company or association.	Undue pressure; water in pipes having become frozen.	Preliminary inquiry only.
723. Bradford; Messrs. W. Rouse & Co.	24 Jan. 1894	—	—	Stop-valve chest - Age not ascertained.	Upper part of chest blown off.	To regulate quantity of steam admitted to pipe.	Do. - - -	The impact of water; the steam-pipe was not efficiently drained.	Do.
724. Lyceum Theatre, Edinburgh; Messrs. Howard & Wyndham.	9 Dec. 1893	—	2	Water tube - - 7 years.	One of the tubes -	Working electric lighting engines.	Boiler Insurance and Steam Power Co., Ltd.	Over-heating through accumulation of deposit.	Do.
725. "Retriever," Fishing Vessel, O.N. 85,212; Mr. J. L. Catchpole.	25 Feb. 1894	—	—	Vertical - - 4 years.	Back of shell - -	Working fishing gear, &c.	Not inspected or insured by any company or association.	Wasting of shell plate - -	Do.
726. Manchester; Messrs. Pullar & Sons.	31 Jan. 1894	—	—	Coil of steel piping - 2 years.	One of the pipes -	Heating premises.	Do. -	Undue pressure; the space for expansion being insufficient.	Do.
727. "Beresford," S.S., O.N. 89,474; Messrs. G. Horsley & Sons.	2 Nov. 1893	1	1	Cylindrical multitubular. 8 years.	Drain plug blown out -	Propelling the vessel.	Lloyd's - -	Wasting of the screw threads in the boiler plate.	Do.
728. "Beresford," S.S.; O.N. 89,474; (same vessel as No. 727).	20 Jan. and 7 Feb. 1894.	—	—	Main steam-pipes - One 2 years' old and one new.	Cracked near flange -	Conveying steam from boilers to engines.	Do. - - -	Pipes too rigid - -	Do.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued*.

No. of Report, Place of Explosion, and Owner of Boiler.	Date of Explosion.	Persons killed.	Persons injured.	General Description and Age of Boiler or Vessel which exploded.	Part of the Boiler which gave way.	Purpose for which Boiler was used.	Whether inspected or insured by any Company or Association, &c.	Cause of Explosion.	General finding of Court if a Formal Investigation held.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
729.									
"Vesper," Trawler, O.N. 27,563; Mr. C. Foster.	16 Feb. 1894	—	—	Vertical - - 6 years.	Uptake - -	Working trawl gear.	Not inspected or insured by any company or association.	Wasting of plates - -	Preliminary inquiry only.
730.									
Almondsbury, Bristol; Mr. W. Luton.	25 Feb. 1894	—	—	Vertical - - 10 years.	Firebox - -	Farm purposes	Do. - - - -	Corrosion of plates of firebox -	Owner blamed for neglecting to have boiler properly inspected, and ordered to pay 15*l.* costs.
731.									
Dundee; the Gilfillan Memorial Hall Co.	7 Jan. 1894	—	—	Coils of piping - 6 years.	Piping in fire - -	Heating a hall	Do. - - -	Undue pressure; the water in the pipes apparently having become frozen.	Preliminary inquiry only.
732.									
Shadwell; the London and India Docks Joint Committee.	2 Mar. 1894	—	1	Cornish type - 40 years.	Flue - -	Pumping machinery.	Do. - - -	Undue working pressure -	Owners blamed for working the boiler at an unsafe pressure, and ordered to pay 35*l.* costs.
733.									
"Progress," S.S., O.N. 87,708; Messrs. R. B. Ballantyne & Co.	27 Jan. 1894	—	—	Cylindrical multitubular. 11 years.	Back plate - -	Propelling the vessel.	Lloyd's - -	Wasting from corrosion, mainly caused by leakage.	Preliminary inquiry only.
734.									
"City of York," S.S., O.N. 79,048; Mr. J. L. Mathews.	17 Mar. 1894	—	—	Cylindrical multitubular. 7 years.	One of the tubes -	Do.	Not inspected or insured by any company or association.	Pitting, accelerated by overheating through deposit of scale.	Do.
735.									
Pershore; Messrs. E. Humphries, Limited.	25 Jan. 1894	2	—	Two brass or gun-metal castings, connected by screw threads. Age not known.	Shell - -	Experimental purposes. A proposed new kind of motor.	Do. - -	The sudden explosion of gas from heated ammonium nitrate and petroleum, and metal weakened through heat.	The owners were blamed somewhat for entrusting the experimental working to any person other than a skilled chemist, but no order was made as to costs.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued.*

No. of Report, Place of Explosion, and Owner of Boiler.	Date of Explosion.	Persons killed.	Persons injured.	General Description and Age of Boiler or Vessel which exploded.	Part of the Boiler which gave way.	Purpose for which Boiler was used.	Whether inspected or insured by any Company or Association, &c.	Cause of Explosion.	General finding of Court if a Formal Investigation held.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
736.									
"Umbria," Trawler, O.N. 99,198; The Grimsby Union Steam Fishing Co.	12 April 1894	—	—	Cylindrical multi-tubular. 2 years.	Crown of combustion chamber.	Propelling the vessel.	Lloyd's and Grimsby Steam Vessels Insurance Co.	Over-heating through shortness of water, the water-gauge being defective.	Preliminary inquiry only.
737.									
"Scott Harley," S.S., O.N. 84,467; the Sarnia S.S. Co.	5 April 1894	1	—	Cylindrical multi-tubular. 9 years.	Joint of bottom man-hole door.	Do.	Lloyd's	Door fitted badly, being too small.	Do.
738.									
"Scottish Queen," Trawler, O.N. 94,539; Mr. R. Brown.	12 April 1894	—	—	Cylindrical multi-tubular. 5 years.	Do.	Do.	Total Loss Mutual S.S. Insurance Co., Sunderland.	The use of unsuitable material for the joint, and want of care.	Do.
739.									
Dover; Messrs. Wiggins, Teape, & Co.	27 March 1894	—	3	Cast-iron tee-piece - Age not known.	Tee-piece	Conveying steam from boilers.	Not inspected or insured by any company or association.	Structural weakness for the working pressure.	The engineer who supplied the tee-piece was blamed for not satisfying himself that it was strong enough for the working pressure, and was ordered to pay 30*l.* costs.
740.									
"Marcia," S.S.; Mr. W. Milburn.	23 Feb. 1894	1	1	Vertical 10 years.	Firebox	Working winches, &c.	Lloyd's	Probably over-heating through adhesion of some foreign substance to the plate.	The owners' superintending engineer, and the chief engineer of the vessel were blamed for not seeing that the safety-valves were properly adjusted, but no order was made as to costs.
741.									
Aberdeen; Messrs. C. Napier & Co.	14 April 1894	—	1	Cast-iron pot 17 years.	Cover	Boiling horse-flesh and bones.	Not inspected or insured by any company or association.	Cover probably injured by over-straining when being secured in its place.	Preliminary inquiry only.
742.									
"Raglan," S.S.; O.N. 87,499; Messrs. J. Cory & Sons.	10 Jan. 1894	—	—	Main steam-pipe - Age not ascertained.	Copper sleeve-piece	Conveying steam to engines.	Lloyd's	The strain caused by movement of machinery during heavy weather.	Do.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued.*

No. of Report, Place of Explosion, and Owner of Boiler. 1.	Date of Explosion. 2.	Persons killed. 3.	Persons injured. 4.	General Description and Age of Boiler or Vessel which exploded. 5.	Part of the Boiler which gave way. 6.	Purpose for which Boiler was used. 7.	Whether inspected or insured by any Company or Association, &c. 8.	Cause of Explosion. 9.	General finding of Court if a Formal Investigation held. 10.
743.									
"Mariner," Tug, O.N. 29,718; Mr. A. McKinnon.	24 April 1894	—	—	Flue 15 years.	Back end of mid furnace	Propelling the vessel.	Not inspected or insured by any company or association.	Internal corrosion	Preliminary inquiry only.
744.									
Leeds Tramway; The Corporation.	12 May 1894	—	—	Locomotive 10 years.	One of the tubes	Working tram engine.	Yorkshire Boiler Insurance and Steam Users Co., Limited.	Wasting from action of sulphurous fumes and particles of coke.	Do.
745.									
Huddersfield Tramway; The Corporation.	22 May 1894	—	1	Locomotive 4 years.	Do.	Do.	Do.	Wasting from action of particles of coke and overheating through deposit of grease and lime.	Do.
746.									
Accrington; Messrs. Moir & Co.	18 April 1894	—	—	Cylindrical pan made of copper. 5 years.	Fastenings of cover	Boiling yarn	Boiler Insurance and Steam Power Co.	Defective method of clamping down the cover.	Do.
747.									
Huddersfield; Messrs. Read, Holliday, & Sons.	27 April 1894	—	1	Vertical Age not ascertained, but exceeded 20 years.	Firebox	Pumping	Not inspected or insured by any company or association.	Corrosion of the firebox plates.	The boiler-maker who sold the boiler to owners was blamed for mis-representing its strength, and was ordered to pay 10*l.* costs; and the owners were held responsible for the negligence of their engine-wright in omitting to properly examine it, and were ordered to pay 30*l.* costs.
748.									
"Toby," Launch; Messrs. Palmer's Shipbuilding and Iron Co., Ltd.	27 April 1894	1	3	Cylindrical multitubular. 10 years.	Bottom of smoke tube	Propelling the vessel.	Do.	Corrosion of the plate	Owners were held responsible for the negligence of their boiler-maker in making an imperfect inspection of the boiler, and were ordered to pay 10*l.* costs.
749.									
"Iron King," S.S., O.N. 94,035; Mr. R. Simpson.	10 Mar. 1894	—	—	Main steam-pipe of copper. 4 years.	Cracked near flange	Conveying steam to engines.	Lloyd's	Pipe too rigid to allow of longitudinal expansion.	Preliminary inquiry only.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued.*

No. of Report, Place of Explosion, and Owner of Boilers. 1.	Date of Explosion. 2.	Persons killed. 3.	Persons injured. 4.	General Description and Age of Boiler or Vessel which exploded. 5.	Part of the Boiler which gave way. 6.	Purpose for which Boiler was used. 7.	Whether inspected or insured by any Company or Association, &c. 8.	Cause of Explosion. 9.	General finding of Court if a Formal Investigation held. 10.
750. "Eureka," S.S., O.N. 86,485; the Eureka S.S. Co.	4 May 1894	—	1	Cylindrical multi-tubular. 12 years.	Joint of lower man-hole door.	Propelling the vessel.	Lloyd's - - -	Condition of door defective and form of material of joint unsuitable.	Preliminary inquiry only.
751. "Kampokus," S.S., O.N. 84,457; Mr. D. Slorach.	22 Feb. 1894	—	2	Cylindrical multi-tubular. 12 years.	Combustion chamber bottom.	Do.	Lloyd's and the North of England Insurance Club.	Corrosion of the plate - -	Do.
752. Congleton; the Astbury Hydraulic Lime and Stone Co.	17 May 1894	1	—	Cornish - - Age not ascertained.	Shell - - -	Working a pug mill.	Not inspected or insured by any company or association.	External corrosion - -	The owners were seriously blamed for neglecting to have boiler properly inspected, and were ordered to pay 40*l.* costs.
753. "Glassalt," S.S., O.N. 84,374; Aberdeen and Glasgow S.S. Co.	29 Mar. 1894	1	—	Cylindrical multi-tubular. 11 years.	Stay blown out of combustion chamber.	Propelling the vessel.	Lloyd's - - -	Stay broken and plate corroded.	Preliminary inquiry only.
754. Blackburn; Messrs. Mitchell, Eccles, & Co.	11 June 1894	1	—	Cast-iron pipe - 16 years.	Pipe at lower end - -	Collecting condensed steam.	Not inspected or insured by any company or association.	The concussion of the water when drain cock was suddenly opened by a watchman.	Do.
755. "Westward Ho," P.S.; Messrs. Hutson & Son.	24 May 1894	1	2	Valve casing - - New.	Door opening - -	Propelling the vessel.	Do. - -	Weakness of design - -	Do.
756. "Little Tom," Smack, O.N. 84,584; Mr. J. Williams.	21 May 1894	—	—	Vertical - - 5 years.	Crown plate - -	Working trawl gear.	Do. - - -	External corrosion - -	Do.

Abstract of Reports on Explosions which occurred during the 12 months ended 30th June 1894—*continued.*

No. of Report, Place of Explosion, and Owner of Boiler.	Date of Explosion.	Persons killed.	Persons injured.	General Description and Age of Boiler or Vessel which exploded.	Part of the Boiler which gave way.	Purpose for which Boiler was used.	Whether inspected or insured by any Company or Association, &c.	Cause of Explosion.	General finding of Court if a Formal Investigation held.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
757.									
"Sabrina," S.S., O.N. 52,789; Messrs. Fenwick and Son.	9 May 1894	—	—	Cylindrical multitubular. 21 years.	Furnace crown	Propelling the vessel.	Not inspected or insured by any company or association.	Over-heating through deposit of grease.	Preliminary inquiry only.
758.									
"Moss Brow," S.S., O.N. 86,634; Mr. F. H. Pyman.	4 May 1894	1	—	Cylindrical multitubular. 12 years.	Drain plug blown out	Do.	Lloyd's	Wasting of screw thread in plate.	Do.
759.									
Stourport; Mr. H. S. Hall	3 May 1894	—	1	Vertical 15 years.	Firebox	Working lathe, &c.	Not inspected or insured by any company or association.	Over-heating through shortness of water.	The attendant was blamed for neglect, but no order was made as to costs.
760.									
"Normand," S.S., O.N. 98,207; Mr. C. Allen.	24 June 1894	—	—	Cylindrical multitubular. 9 years.	Front end plate	Propelling the vessel.	Lloyd's	External corrosion	Preliminary inquiry only.
761.									
"Bee," S.S., O.N. 21,025; Mr. J. Davies.	27 June 1894	—	—	Cylindrical multitubular. 17 years.	Top of combustion chamber.	Do.	Not inspected or insured by any company or association.	Over-heating, due to shortness of water.	Do.
762.									
"Bernard," barge; Mr. C. Crawley.	22 June 1894	—	2	Cylindrical multitubular. Age not ascertained.	Shell	Working pump	Do.	Corrosion of the plate	Owner blamed for neglecting to have boiler examined, and ordered to pay 10*l.* costs.
763.									
"Lombard," S.S., O.N. 76,952; Mr. V. T. Thompson.	3 May 1894	—	—	Cyllindrical multitubular. 17 years.	Joint of bottom man-hole door.	Propelling the vessel.	Lloyd's	Badly fitting door, jointing material of unsuitable section.	Preliminary inquiry only.
	Total	24	54						

APPENDIX B.

Classification of Causes of Explosions and Types of Boilers, 1893–94.

Causes of Explosions.	No. of Cases.
Deterioration or corrosion, or safety-valves, &c. defective, Nos. **661, 662, 663, 664,** 665, 667, 668, 669, 671, 673, 674, 675, 677, 679, 681, 683, 688, 689, 695, 696, 703, 706, **716, 719, 725, 727,** 729, 730, 733, 734, 743, 744, 745, 747, 748, 751, 752, 753, 756, 758, 760, 762.	42
Ignorance or neglect of attendants, &c., Nos. 660, **676, 684, 686, 691, 692, 693, 694, 697, 698, 699, 700, 701,** 702, 704, 705, 707, 708, 709, 710, 711, 712, 714, 715, 717, 720, 721, 722, 724, **731,** 736, 741, 754, 757, 759, 761.	36
Defective design, workmanship, material, construction, or undue working pressure, Nos. **666, 672, 678, 682,** 685, 690, 713, 718, 723, 728, 732, 737, 738, 739, 742, 746, 749, 750, 755, 763.	20
Miscellaneous, Nos. 670, 680, 687, 726, 735, 740 - - - - - - -	6
Total - - - -	104

Nos. 663, 664, 665, 669, 670*, 672, 673, 676*, 677, 680*, 684*, 685*, 689, 697*, 716, 717*, 718, 724*, 727, 728, 733, 736*, 737, 738*, 740*, 742, 744, 745, 746, 749, 750, 751, 753, 758, 760, 763 = 36 cases in which the boilers were under the inspection of Public Associations or Companies or of Board of Trade Surveyors.

* In the cases marked with an asterisk the explosions were not due to any defect in the condition of the boiler.

Types of Boilers.

	No. of Cases.
V V V V V V V V Vertical, Nos. 660, 661, 671, 675, 681, 682, 685, 686, 694, 696, 719, 725, 729, 730, 740, 747, 756, 759 - - -	18
F Marine, Nos. 663, 665, 669, 670, 677, 679, 680, 683, 689, 706, 716, 727, 733, 734, 736, 737, 738, 743, 748, 750, 751, 753, 757, 758, 760, 761, 762, 763.	28
Heating apparatus, Nos. 674, 691, 692, 693, 698, 699, 700, 701, 702, 704, 705, 707, 708, 709, 711, 712, 714, 715, 720, 721, 722, 726, 731.	23
E L W L L C C L L W C C Land, cylindrical, Cornish, Lancashire, &c., Nos. 667, 672, 676, 684, 688, 695, 697, 703, 717, 724, 732, 752 -	12
Locomotive, Nos. 662, 673, 710, 744, 745 - - - - - - - -	5
Kiers, drying cylinders, &c., Nos. 678, 741, 746 - - - - - - -	3
Still, No. 687 - - - - - - - - - - - - - - - -	1
S S S V S V S V V S V Steam-pipes, stop-valves, &c., Nos. 664, 668, 690, 718, 723, 728, 739, 742, 749, 754, 755 - - -	11
Miscellaneous, Nos. 666, 713, 735 - - - - - - - -	3
	104

Vertical boilers marked V were used on board vessels, the other vertical boilers were used on land.

The marine boiler denoted by F was a flue boiler, the other marine boilers were cylindrical multitubular.

The land boiler denoted by the letter E was cylindrical and externally fired, those marked C were Cornish, those marked L Lancashire, and those marked W water tube boilers.

Steam-pipes, stop-valves, &c., denoted by the letter S were used on shore, and those marked V were used on board vessels.

APPENDIX C.

STATISTICS FOR PAST YEARS.

TOTAL NUMBER of EXPLOSIONS dealt with since passing of the Acts, NUMBER of LIVES LOST, and NUMBER of PERSONS INJURED.

Year.	No. of Explosions.	No. of Lives Lost.	No. of Persons Injured.
1882–83	45	35	33
1883–84	41	18	62
1884–85	43	40	62
1885–86	57	33	79
1886–87	37	24	44
1887–88	61	31	52
1888–89	67	33	79
1889–90	77	21	76
1890–91	72	32	61
1891–92	88	23	82
1892–93	72	20	37
1893–94	104	24	54

APPENDIX D.

REPORT by the SOLICITOR to the BOARD OF TRADE on FORMAL INVESTIGATIONS into BOILER EXPLOSIONS during the Year 1893–94.

In the year ending 30th June 1894 the number of Formal Investigations held was 23, and they related to—

6 Vertical boilers used on land.
2 „ „ „ board vessels.
6 Land „ (cylindrical, Cornish, Lancashire, &c.)
1 Locomotive „
1 Water tube „
2 Marine „
1 Tee-piece of steam-pipe.
1 Heating pan.
1 Heating apparatus.
2 Miscellaneous.

These explosions caused the death of 12 persons, and 25 persons were injured.

Loss of life and injuries.

Explosions not accidents.

In no case has the Court attributed the explosion to an unavoidable accident, and in three cases only have they found that no one was to blame for the explosion. The first of these cases was No. 686, an explosion due to over-heating from shortness of water, but the evidence was not sufficient to enable the Court to determine how the deficiency of water occurred, or to say that blame was attributable to anyone. The second case, No. 704, was the explosion of a heating apparatus owing to the circulating pipes being blocked with ice, and the Court strongly urged that apparatus of this description should be fitted with safety-valves, and the person who fitted the apparatus was blamed for not reporting defects which he had observed. The third case, No, 740, was one of over-heating owing to the adhesion of some foreign substance to the water side of the firebox plate, and, whilst the Court found that some measure of blame attached to the superintending engineer and to the engineer of the vessel in connection with the adjustment of the load on the safety-valve, they found that no one was to blame for the explosion. Case No. 735 related to the explosion of a generator containing nitrate of ammonia and petroleum. This was used for the purpose of carrying on experiments with a view to perfect an invention for a motor. The Court found the owners somewhat to blame for employing a man of insufficient experience in the use of these chemicals, but they were relieved from payment of costs.

Examinations.

In seven cases the explosions were due to neglect of examination by competent persons, the boilers having been worked for periods varying from four to 32 years without such examination.

In six cases the examinations made were careless or perfunctory, and defects which existed were not discovered.

Two explosions were due to shortness of water through the neglect of the attendant.

Two explosions were due to overloading safety-valves.

Two explosions were due to weakness of design and construction.

Insurance companies.

In three cases the boilers were insured, and in 20 cases they were not insured. In case No. 676 it was proved that the boiler was not sufficiently prepared for examination by the insurance company's inspector, and the company had so advised the owners. In No. 685 a question arose as to whether the insurance company's inspector had examined and passed as efficient a boiler with a safety-valve, around the wings of which a ferrule had been fitted. The Court found that he had not passed such a mounting, and that between the time of his examination and the explosion the valve had been changed. In case No. 740 a question arose as to whether one of Lloyd's surveyors had examined and passed a boiler for a working pressure in excess of that which should have been properly allowed, and also as to whether he had passed a safety-valve which was inoperative. The Court found that the boiler was fit for the working pressure allowed by the surveyor, viz., 80 lbs. per square inch, and that when he passed the safety-valves they blew off freely at 60 lbs.

Boiler-makers, repairers, &c.

In five cases persons other than the owner or user of the boiler (or their servants) were found to blame.

In case No. 688 a hot-water engineer professed to have examined the boiler, and the Court found that he had taken upon himself work which he was quite incapable of performing. In case No. 704 the engineer who fitted the apparatus was found somewhat to blame. In case No. 713 a cast-iron Decoudun bed or ironing machine burst into fragments. The Court found that the person who supplied and turned the casting and discovered defects in it was to blame, that the firm who contracted with the contractor to the laundry company to supply it and to whose order it was delivered were to blame for neglecting to satisfy themselves that the work was properly executed before delivery, and that the contractor was to blame for neglecting to examine it upon delivery. In case No. 739 the Court found that the contractor had failed to specify to the manufacturers the working pressure for which the tee-piece of pipe was required, and that he had thereby broken his contract, and in case No. 747 the Court found that the vendor had fixed the working pressure without having made a proper examination of the boiler.

In 15 cases the Court found the owners or users of boilers directly responsible for the explosions and in four cases they held them responsible for the neglect of their servants, and they were ordered to pay a portion of the costs and expenses of the investigation. These orders varied in amount from 5*l.* to 60*l.*

Whilst the Commissioners have power to order any person summoned before them to pay the costs of an investigation, their practice has been to take into consideration the conduct of the person against whom an order has been made, and the amount so ordered to be paid affords some indication of the degree of blame or neglect. The following are the amounts which have been ordered to be paid :—

5*l.* in 4 cases.
10*l.* in 4 cases.
15*l.* in 4 cases.
20*l.* in 1 case.
30*l.* in 3 cases.
35*l.* in 1 case.
40*l.* in 3 cases.
50*l.* in 1 case.
60*l.* in 1 case.

Explosions continue to arise through the ignorance of users and owners of boilers, when these persons have been in a small way of business. So long as a boiler does not leak they appear to think that it is safe to work, and they continue working it without thinking of the necessity for a periodical examination by a competent person.

WALTER MURTON,
Solicitor, Board of Trade.

July 1894.

Explosives Act, 1875 (38 Vict. c. 17).

EIGHTEENTH ANNUAL REPORT

OF

HER MAJESTY'S INSPECTORS OF EXPLOSIVES;

BEING THEIR

Annual Report for the Year 1893.

Presented to both Houses of Parliament by Command of Her Majesty.

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1894.

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EIGHTEENTH ANNUAL REPORT OF HER MAJESTY'S INSPECTORS OF EXPLOSIVES;

BEING THEIR

ANNUAL REPORT FOR THE YEAR 1893.

SIR,

Home Office, 1st January 1894.

Introductory.

IN accordance with the 57th section of the Explosives Act, 1875, we, being the Government Inspectors under that Act, have the honour to furnish this the Eighteenth Annual Report of our proceedings and of the working of the Act during the year ended 31st December 1893.

It will be seen that among the signatures to this Report the name of Lieut.-Colonel Cundill no longer appears, and in its place is that of Captain J. H. Thomson, R.A.

The two of us with whom Lieut.-Colonel Cundill has been associated for upwards of 10 years, desire to express their very great regret at the enforced retirement of their colleague through ill-health.

During the period that Lieut.-Colonel Cundill has occupied the position of one of Her Majesty's Inspectors of Explosives, he has rendered very valuable and efficient services; and his name will always be associated with the "Dictionary of Explosives," which he compiled, and which it is not too much to say now enjoys a world-wide reputation, and has furnished a model on which other nations are basing similar compilations.

It has been especially gratifying to receive—as we have done—a large number of expressions of regret at Lieut.-Colonel Cundill's retirement and its cause, from members of the trade, coupled with their testimony as to his unfailing courtesy in his relations with them.

In succession to Lieut.-Colonel Cundill you were pleased on the 12th June 1893 to appoint Captain J. H. Thomson, R.A., an officer whose previous experience in connexion with explosives (especially during the three years that he filled the position of Secretary to the War Office Committee on Explosives,) appeared to specially recommend him for this post.

Modifications of law during year.

The only modification in the previously existing law that has been made during the year is a new order of the Secretary of State, No. 3 (*c*), dated 30th October 1893, which authorises the packing of explosives of the 1st division of the 3rd (nitro-compound) class in packages constructed of metal, with the consent of and under conditions approved by a Government inspector. The immediate object of this order was to place the manufacturers of smokeless powders of which nitro-glycerine is an ingredient (such as amberite No. 1 and ballistite) on equal terms with those who produced smokeless powders consisting essentially of nitro-cellulose,* the latter being able to send out their explosive in "tin" canisters in the same manner as gunpowder, while the former were restricted to the use of packages without any metal in their construction. The new Order is given in Appendix F.

The modifications of the original law which have been effected since the Act of 1875 came into operation, are those embodied in Orders in Council Nos. 1(*a*), 6(*a*), 7(*a*), 7(*b*), 10(*a*), 12, 13, 14, and in the Orders of Secretary of State, Nos. 3(*a*), 3(*b*), and 3 (*c*), and in the Explosives Substances Act, 1883.

Inspection work.

Owing to the ill-health of Colonel Cundill and his subsequent retirement, as above stated, the inspecting power of the Department has been much reduced during the year. For, until Captain Thomson's appointment, there were two officers only instead of three; and, moreover, as each of those two had to attend to the work of the "Office" in London on alternate months instead of on one month out of every three, his time for the work of inspection was, *pro tanto*, reduced. Nevertheless,

* *See* Annual Report for 1891, p. 5.

we have visited every factory and magazine on our books at least once during the year, and in the case of the factories more than one-half have been visited a second time. As in 1892, it is with very great satisfaction that we are able to report that there has been no falling off in the high standard previously attained in the great majority of these establishments, while some of the places which had formerly lagged behind have been brought more into a line with the rest, and the condition of the factories and magazines is now generally decidedly better than it was a year ago.

Accidents.

The number of deaths from accidents by fire or explosion in manufacture was 6, which is slightly above the very satisfactorily low average for the past 10 years, viz., 5·9. As stated in our last Annual Report, the figures show an extraordinary and most satisfactory contrast with those which obtained before the Act came into operation. It should also be remembered that not only has the actual number of factories largely increased, but also in many cases the amount of output of an individual factory, and consequently the number of hands employed and the chances of accident. Moreover, the risks attending the manufacture of wholly new explosives, to which a large proportion of the new factories are applied, are less well known, and, therefore, not so easy to provide against. We have dealt with these points more fully in the "Accident" section.*

With these preliminary observations we will pass to the detailed examination of the various points on which it falls to us to report.

I.

Manufacture.

Number of factories.

The total number of factories (under continuing certificate and license) is now 127 (exclusive of "small firework" and "toy firework" factories, which will be dealt with separately), being a decrease of two on last year, when the number stood at 129.

The factories which have ceased to exist during the year are as follows, viz.:—

No. 22, for gunpowder. The factory had been in disuse practically for some years.
No. 27, for fireworks.
No. 83, for fireworks.

One new factory has been licensed. Altogether 102 factories have been licensed since the Act came into operation, viz.: 101 during the 17 years from 1876 to 1892 and one in 1893, or an average annual increase of $5\frac{2}{3}$. This increase of 102 is not far short of double the number of factories existing at the passing of the Act.

Factories under continuing certificate.

The number of factories under Continuing Certificate is now 42, being two less than last year. The reduction in the number of such factories since the Act came into operation is 13, nearly one-quarter of the total original number, viz., 55.

Factories under license.

The present number of factories under License is 85, as at the end of 1892 (exclusive of "small firework" and "toy firework" factories), a new one having, as already stated, been licensed, while one has ceased to exist during the year.

Applications for factory licenses.

The number of applications for new factory licenses received during the year was six, and there were three outstanding from the previous year. One was confirmed during the year, and eight still remain under consideration.

The new factory is as follows, viz.:—

Factory No. 157, for electric fuzes and electric detonator fuzes.

Appendix A. gives a table of all factories at present in existence, with the classes of explosives authorised to be manufactured therein; while Appendix B. specifies in detail the various natures of explosives authorised for the different factories. Appendix D. contains descriptions of the explosives, and Appendix E(1) gives the distribution of the factories throughout the country.

The growth of the trade in explosives since the passing of the Explosives Act in 1875 has been very remarkable—not only has the number of factories increased from 55 to 127, but a large proportion of the factories have themselves enormously expanded, some of them having more than doubled in size. This growth of the trade may to some extent be indicated by the increase in the number of explosives which may be manufactured in the several factories, or conversely by the number of factories in which each kind of explosive can be made. As this information will, doubtless, be of great interest to the manufacturers, we have prepared a table showing the annual

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* *See* page 23.

variation in respect of each nature of explosive during the 18 years since the passing of the Act. This will be found in Appendix C.

System of licensing.

We see no grounds for modifying the favourable opinion which we have frequently expressed as to the sound practical working of the system of licensing as laid down by the Act, which is calculated to ensure a thorough investigation of all technical details when the draft license is under consideration at the Home Office, while it affords ample security for the protection of the public and of the local interests concerned when the application comes before the Local Authority.

Factory amending licenses.

Twenty-nine amending licenses for factories have been applied for during the year, and ten were outstanding from the year before. The number of amending licenses actually confirmed during the year was 34. The number confirmed during the previous 17 years was 579. The consideration and preparation of the amending licenses often entail very heavy work on the department.

Changes in the list of licensed explosives.

The following changes have occurred in the list of licensed explosives during the year:

The following have been added to the list of authorised explosives:—

Magic candle pin crackers.

High tension electric fuzes and electric detonator fuzes (Brain's Patent) and other high tension electric fuzes and electric detonator fuzes.

The full definitions of the above, as contained in the licenses regulating their manufacture and importation, will be found set forth in Appendix D.

In the case of the magic candle pin crackers, owing to their liability to explosion *en masse*, it was deemed necessary to require them to be packed in limited numbers in separate packets inside separate wooden boxes (*see* Appendix D.).

Carbonate of magnesia, &c.

The permission which was accorded to Mr. Kraftmeier in 1888* to add carbonate of lime or carbonate of magnesia (not exceeding one per cent. of the finished explosive) to gelatine dynamite No. 1 and gelatine dynamite No. 2, and (under an amending license) to blasting gelatine No. 1 and blasting gelatine No. 2, has been extended to the National Explosives Company, Limited, for the same materials.

Collodion cotton.

A more intimate acquaintance with the properties of nitro-cotton, which has been brought about in a large measure from its employment in the manufacture of the various smokeless powders, has brought to light the fact that its explosiveness does not depend, as hitherto supposed, on the degree of its insolubility. All nitro-cotton, however soluble, is now admitted to be "explosive." The question, therefore, whether collodion cotton, which is largely used for the manufacture of collodion, should be ranked as an explosive, has again come under our consideration; and we have decided that for the present there is no necessity to bring it within the scope of the Act, so long as it is either in solution (in alcohol and ether) or wet, or saturated with methylated spirit and inclosed in air-tight cases, in any one of which states it is available for conversion into collodion.

Alteration in definitions of explosives.

The definitions of Cooppal's Powder, Di-flamyr and of some of the fuzes have been slightly altered during the year. The new definitions will be found in Appendix D. The name of Troisdorf Smokeless Powder has been altered to Chilworth Smokeless Powder, and that of Patent Igniters to Bickford's Patent Volley Firers.

Explosives submitted during the year.

The explosives which have been submitted during the year, with a view to their being placed on the authorised list, will be found in Dr. Dupré's Report, page 15. Explosives which have passed the tests successfully become "authorised" so soon as any license for manufacture or importation for general sale is applied for and granted. They in the meantime occupy the position of what may be called licensable explosives.

Quick-firing ammunition. Removal of some of the restrictions affecting the same.

Quick-firing ammunition, which was previously licensed for manufacture only for direct issue to Her Majesty's land and sea forces, was allowed, in 1891, to be made for export by water transport only in the case of one factory situated on the banks of the Thames,† as such direct water transmission obviates the possible dangers of the conveyance of this ammunition under ordinary conditions of transport by land which had hitherto barred its general manufacture.

The manufacture of this ammunition was further extended in 1892, permission having been given in the case of one factory‡ to make it for private sale, subject to

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* *See* Annual Report for 1888, p. 8.

† Factory No. 138 (*see* Annual Report for 1891, p. 5).

‡ Factory No. 47.

the condition that it is packed for conveyance in special packages approved as being in accordance with the arrangements for diminishing the risk from concussion, suggested in the memorandum issued on the 14th November 1888.* Power is reserved to determine the use of such packages if it shall appear at any time that they do not afford reasonable security against this risk or are otherwise open to objection. This permission was extended to another factory† during the past year subject to the same conditions.

Spontaneous ignition of coloured fires.

In consequence of the numerous cases which have occurred of spontaneous ignition of coloured fire compositions containing chlorate of potash and sulphur, steps are being taken to restrict the manufacture of such compositions, and a communication has been made to the firework makers to ascertain their views on the subject. (*See* page 33.)

Memorandum for inventors.

For the assistance of inventors who desire to have explosives examined with a view to their being placed on the list of authorised explosives, a memorandum which was prepared some time ago, giving the necessary information as to the steps to be taken by them, and which has appeared in previous Annual Reports, is reprinted in Appendix R.

Visits to factories.

During the year we have paid 205 visits to the factories, which now number 127, all of them having been been visited once and more than half of them a second time.

There has been no falling off in the general improvement referred to in our previous reports in the factories. The high standard of excellence which has been gradually reached since the passing of the Explosives Act has, as a rule, been fully maintained. We believe that, taken as a whole, the factories for explosives in the United Kingdom will compare extremely favourably with any other factories, whether in the Kingdom or abroad.

Our relations, too, with both employers and employed generally continue, we are glad to say, to be on the same satisfactory footing as they have now been for several years past.

Proceedings for irregularities in the factories are now, happily, of rare occurrence. It is perhaps unavoidable that we should find breaches of the Act in the course of our visits to some of the factories, but they are usually of a minor character, and, as a rule, are at once rectified when attention is drawn to them. In a few instances, however, such irregularities, although separately of a minor character, have been more numerous than could be reasonably passed over, and we have had to take strong measures, by energetic remonstrance and otherwise, to prevent a repetition of such infraction of the law.

Proceedings taken in case of factories.

In four cases only was the institution of proceedings actually necessary. These cases were as follows:—

Mr. Thomas Bennett, the occupier of a firework factory at Bacchus Lane, Soho, near Birmingham, against whom proceedings were taken in 1892,‡ and who, in default of paying the fine of 25*l.* then inflicted, was sent to prison, was summoned for various offences committed in his factory on Sunday, the 8th of October. Before, however, the case went into court, Mr. Bennett desired to be permitted to surrender his license, and on his doing so, the charges against him were withdrawn. The factory (No. 83) has accordingly been closed, and struck off the list of licensed factories.

In consequence of an accident (No. 8 of 1893, *see* Appendix W.), proceedings were instituted against the Maxim-Nordenfelt Guns and Ammunition Company, Limited, and a conviction was obtained, a penalty of 10*l.* being inflicted for a breach of the terms of their license as to packing explosive.

Mr. Joseph Wells, the occupier of the factory at Riversdale Works, Wandsworth, was prosecuted for four offences, and convicted on all of them, fines in the aggregate amounting to 50*l.*, with 5*l.* 5*s.* costs being inflicted.

The Midlothian Gunpowder Company, Limited, were prosecuted for three offences at their factory at Camilty Mill, West Calder, and were convicted, fines amounting to 60*l.* being imposed.

The particulars of the offences in the last three cases will be found in Appendix T(*a*).

In addition to the above, we found it necessary to place explosive under seizure in one factory, viz., in that of the Fortis Powder and Explosives Company, Limited, at Denaby. It was subsequently released without further action.

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* *See* Annual Report for 1888, pp. 5, 69.
† Factory No. 138.
‡ *See* Annual Report for 1892, p. 5.

No instance of the unlawful entry of a factory magazine has been brought to our notice during the year. Unlawful entry.

It has not been found necessary to give any notice under sections 24 and 56 of the Act to require a reduction of the amount of explosive present in a building.

During the year there have come under our notice 40 accidents in manufacture, causing seven deaths and injuring 20 persons. They are fully dealt with in the Accident section of this Report and in Appendix W. Accidents in factories.

No licenses for "toy firework factories" (*i.e.*, for the making of "bon-bon crackers," "throwdowns," and "amorces") have been granted during the year. The number of such factories at present in existence is 11 (*see* Appendix B). All these factories, except one, near Manchester, are in the metropolitan district. Toy firework factories.

We have obtained no fresh returns of "small firework factories" from the Local Authorities since 1892, when the number licensed was 19 only (all of which are in England), as compared with 24 in 1885, and 29 in 1880. As we stated in our Annual Report for 1892, this is a very marked falling off, but on the other hand, three new factories had been licensed in the place of them during 1891 and 1892. The limited scale of manufacture allowed in a small firework factory does not generally admit of the production of more fireworks than is sufficient for small displays, and the squibs, crackers, &c., sold about the 5th November, and known as "shop-goods," from the manufacture of which very little profit is derived. The occupiers of these factories, therefore, find a license for a factory proper, where they can carry on work on a much larger scale, more to their interest. Small firework factories.

The distribution in counties of the small firework factories now on our books is shown in Appendix E(2). Four of these are in the London district, two in the neighbourhood of Birmingham, and two near Bristol, the remainder being scattered over the country.

We have visited 10 of these during the year, and found that the improved condition noticed in 1892 has been maintained.

We have not had occasion to take proceedings against the occupiers of any small firework factories, either ourselves or through the Local Authority.

It is satisfactory to be able to state, in connexion with the illegal manufacture of fireworks at Bridgwater referred to in previous Annual Reports,* that arrangements have been made to limit the local manufacture to the making of the cases, which are sent to a licensed factory to be filled. These fireworks have been used at a Carnival, held annually about the 5th November, which has not yet been abandoned. We hope that this dangerous manufacture in private houses is also being given up in the other towns where it has prevailed. Illegal manufacture.

For making squibs in a shop at Gravesend, two men were convicted and fined 5*l.* and 2*l.* respectively.

A case of illegally drying gunpowder, which had become slightly damp in keeping, over a stove in a room for filling cartridges in connexion with registered premises at Chippenham is referred to under the head of Registered Premises.† Proceedings were instituted against the occupier, and he was fined 2*l.*

The particulars will be found in Appendix T(*b*).

II.

Storage.

Magazines.—The total number of magazines (under Continuing Certificate and license) is now 381,‡ being an decrease of one on last year, when the number stood at 382. Number of magazines.

The decrease of one has been caused by six having been struck off our books, while five only have been added during the year. The total number of new magazines licensed since the Act came into operation is 279.

As regards magazines under Continuing Certificate, the number now in existence is 142, the same as last year. There has been a reduction of 57 out of the 199 magazines for which Continuing Certificates were obtained when the Act came into operation. Magazines under Continuing Certificate.

* *See* Annual Report for 1891, p. 7; for 1892, p. 7.

† *See* p. 10.

‡ The number actually in use is 378, Nos. 169, 170, and 178, having given notice, under section 13, of temporary disuse. In addition, there exists on our books a magazine in Erith Marshes (No. 200), established by this Department in conjunction with the Metropolitan and City Police for the deposit of seized explosives. This magazine is, however, exempt from the operation of the Act under section 97, and is not included by us in our list of magazines.

Magazines under license.

As regards magazines under License, the number now in existence (including the three Mersey magazines, which have been subject to our inspection from 15th January 1884) is 239, being a decrease of one on last year. During the year six have ceased to exist, viz., No. 226 (Cumberland), Nos. 260, 261, and 273 (Derby), and No. 285 and 394 (Cornwall), and five new magazines have been licensed.

All of the new licenses have been granted on the principle adopted on the 1st January 1891, and referred to in our Annual Report for 1890, page 8; that is to say, they are licensed to contain any "authorised" explosive of Classes 1 to 4. In some cases detonators are also allowed to be stored in an annexe erected for the purpose.

We have found that the new system is very satisfactory to the trade, and it saves the expense and trouble formerly incurred when the occupier of a magazine wished to store a new explosive, or even when the definition of an explosive was, however slightly, altered.

In Appendix E(1) will be found the distribution of the 381 magazines throughout the country.

Removal of Mersey magazines to new site.

In our last Annual Report (page 8), we referred to the Inquiry which was then in progress as to the place of mooring of the Mersey Floating Magazines in consequence of the site appointed as the result of the Inquiry of 1890 having become unsuitable. The result of the Inquiry, as set forth in the Report, dated 30th January 1893, was to restore the magazines to what may be designated, broadly, the 1881 area, *i.e.*, the area indicated by the dotted red lines on the plan to Appendix H. of the Report of Admiral Phillimore's Committee of 26th August 1881, and from which the magazines were removed in 1890, in consequence of the alteration in the bed of the river having prevented the explosive being any longer stored below the water line (*see* Report of 24th June 1890). The fluctuations in the bed of the river having once more restored to the 1881 site a sufficient depth of water to remove this objection, it became possible to replace the magazines on such site. The necessary order substituting the 1881 area for the 1890 area was made on the 27th May last, and appeared in the "London Gazette" of the 30th May 1893.

Applications for magazine licenses.

The number of applications for magazine licenses during the year was eight, and there were 12 outstanding from the previous year. Of these, six were withdrawn or abandoned, and five were confirmed. Nine are still in progress.

Magazine amending licenses.

Fifteen magazine amending licenses have been applied for during the year, and there were five outstanding from the previous year. Of these 20 applications, two were withdrawn, 12 received confirmation, and six are in progress. Owing to a large number of the magazines being now licensed for all authorised explosives of Classes 1 to 4, the necessity for amendment of the license whenever a new explosive is to be stored no longer exists.

Protection of floating magazines from fire.

In consequence of the narrow escape from an explosion on board the "Loch Sloy" referred to in the Accident Section of this Report,* a circular was addressed in December to the occupiers of floating magazines in which a fire is allowed, suggesting that the woodwork in the immediate vicinity of such fire should be protected with two sheets of iron or steel (preferentially with a small air space), or with one sheet of iron or steel and a layer of asbestos. A copy of the circular is given in Appendix O.

Visits to magazines.

During the year we have paid 406 visits of inspection to the 381 magazines in the United Kingdom. All have been inspected once, and, as the numbers show, a small proportion of them more than once. We are pleased to be able to report that there has been no falling off in the standard of excellence which the great majority have attained since the passing of the Act; and in many instances the advance has been appreciable.

Unlawful entry.

Two instances of unlawful entry of magazines have been brought under our notice during the year.

In the first, on the 31st March, the outer iron door of the Magazine (No. 235), at Houndsham, near Bristol, in the occupation of Mr. Albert Ricketts, was prized open from below, and as a stout inner door of wood offered effective resistance to this means of entry, holes were bored into it, and thus an irregular opening made, through which, presumably, a boy was put into the building. This case appears to indicate the value of iron-plating to wooden doors, applied between two layers of wood, like a

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* *See* p. 35.

sandwich. The perpetrators stole 150 lbs. of gelignite from the magazine, and 1,000 detonators from the annexe thereto.

In the second instance, one of us on reaching the Magazine (No. 141), at Greets Green, near Birmingham, in the occupation of Messrs. Pigou, Wilks, and Laurence, Limited, on the 8th December, in the course of an ordinary inspection found the doors of one of the compartments standing open. They were both of wood and opened inwards, thus opposing no real resistance to blows from the outside. Moreover, the inner door was secured by a padlock only. The doors of this magazine will now be altered to open outwards, the outer door being iron-plated. Only a small quantity of gunpowder blasting cartridges appeared to have been stolen.

Proceedings taken in the case of magazines.

We have not found it necessary during the year to institute proceedings in respect of any irregularity in magazines.

In two cases, however, we placed explosive under seizure for an irregularity in the magazine, viz., at Magazine No. 363, in the occupation of Messrs. Darbishires, Limited, at Penmaenmawr, and at Magazine No. 282, in the occupation of Messrs. Thompson & Co., of Wigan. In both cases, detonators were kept in contravention of the terms of the license. They were subsequently released without further action being taken.

In one case, the occupier of a magazine (No. 186, Durham), instituted proceedings against one of his workmen whom we found in the magazine in his ordinary boots, in the course of our inspections. The workman was fined 1*l.* and costs.

There has been no accident by fire or explosion in any magazine during the year.

Stores.

Stores.—We have not obtained fresh returns of stores from the Local Authorities since 1892, when the number was 2,188, of which 1,698 were in England and Wales, 417 in Scotland, and 73 in Ireland.

The detailed distribution of these stores is shown in Appendix E(2). We have continued the practice of devoting as much time as we could spare from other duties to inspecting a certain number of stores as samples in such districts as we have been able to visit during the year, and thus obtaining some measure of the degree of efficiency with which the Act is worked within such districts. We have in this way succeeded in visiting 42 during the year.

As last year, the condition of the stores still continues to advance, and great progress has been made in the way of rendering them more secure, particularly in certain districts. The outer doors of the stores in some counties are now very generally protected by iron plating. Great improvement is also visible in the construction of new stores, which we have recommended should be built on the general lines laid down for the construction of new magazines. We are glad to notice that the Chief Constables of counties have, as a rule, taken strong action in this direction, in consequence of the recommendations made to them by us in 1885.

Unlawful entry of stores.

One case of unlawful entry of a store has been brought to our notice during the year. It occurred at Store No. 1,273, at Leeds, in the occupation of Messrs. Cliff and Sons. This store had two doors, both fitted with locks, the outer also having a bar across it secured with a Chubb's padlock. A small quantity of explosive was taken.

Proceedings and seizures in case of stores.

It is gratifying to be able to state that in no instance were we compelled either to place explosive under seizure in a store or to institute proceedings against the occupier, and in no instance was a prosecution undertaken at our instigation by the Local Authority.

There has been no accident by explosion or fire in a store during the year.

Registered premises.

Registered Premises.—As in the case of stores, we have not obtained fresh returns of registered premises from the Local Authorities since 1892, when the number was 27,966, of which 24,846 were in England and Wales, 2,287 in Scotland, and 833 in Ireland.

A small proportion of these registered premises will be found in mines, quarries, and collieries, where the quantity of explosive used is insufficient to require a store license.

The detailed distribution of these registered premises is shown in Appendix E(2).

Proceedings and seizures in case of registered premises.

During the year we have visited 134 registered premises, chiefly in boroughs and towns. In five cases proceedings were instituted by the Local Authority at our instigation. (*See* Appendix T(*b*).) In one of them an explosion (No. 18) occurred in consequence of the occupier not taking proper precautions in the filling of cartridges;

and in the same case the occupier was also engaged in drying gunpowder, which had become damp in keeping, over a stove, which, moreover, was in the filling room; in another, explosive was sold to a child under 13 years of age, and an accident (No. 2) occurred by which the child's brother received injuries to which he succumbed. Proceedings were instituted by the Local Authority against the vendor (R. Sissons) for the offence, and a penalty was inflicted, *see* Appendix T(*b*).

Illegal storage.

As usual, some cases of illegal storage have come to our notice. These will be found in Appendix T(*b*.), convictions having been obtained as follows:—

Messrs. Hugh Kennedy and Sons, of Partick Hill, near Glasgow, were fined 2*l*. 10*s*. for keeping gelignite in a shed.

Mr. George Nicholson, Receiver of the Vauxhall Colliery Company, Ruabon, in liquidation, was fined 5*l*. and costs for keeping various explosives in an unauthorised place.

Mr. Thomas Bushby, of Llangollen, was fined 3*l*. and costs for keeping guncotton and blasting powder in unauthorised places.

Messrs. Roberts and Maginnis, of Llangollen, were fined 1*l*. and costs for keeping blasting powder in an unauthorised place.

The Glyn Ceiriog Granite Company, of Llangollen, were fined 6*l*. 11*s*. and costs for two offences in keeping various explosives in unauthorised places.

Doubtless there have been many other cases of illegal storage, and convictions for the same, which have not come under our notice.

Breaking bulk.

As in 1892, we continue to find occasionally instances of "breaking bulk" on registered premises of quantities of explosive exceeding 1 lb. To this point we always draw the special attention of the occupiers and of the local officers, as it is a fruitful source of danger. It is always to be borne in mind that the explosion of any considerable amount of explosive upon registered premises is likely, as a rule, to be more disastrous than in a properly isolated magazine or store. If 100 lbs. of powder explodes in a house or shop in the middle of a town, the personal and structural injuries are likely to be far more serious than if a much larger amount exploded in an isolated building.

The officer of the Local Authority has, in all cases where it was practicable, accompanied us on our visits to the registered premises.

Accidents in registered premises.

There have been six accidents in registered premises during the year, three of them having occurred in filling rooms for the manufacture of small-arm cartridges, under section 46. Fortunately none of them proved fatal. These accidents are dealt with in the "Accident" Section of this Report.*

III.

Packing and Conveyance of Explosives.

Packing of explosives.

We have had no reason to find fault with the character of the packages generally in use for the various explosives. As a rule they fulfil their purposes excellently.

As stated in the introductory portion of this Report,† a modification in the law as regards packing has been made by Order of Secretary of State, No. 3(*c*), by which the use of metal packages for nitro compounds of Class 3, Division 1, was authorised with the consent of, and under conditions approved by, a Government Inspector, in order to meet a special requirement of the trade in respect of smokeless sporting powders.

Cases of illegal packing.

The Maxim-Nordenfelt Guns and Ammunition Company, Limited, of Erith, were convicted for a breach of the terms of their license as to the packing of explosive, and fined 10*l*. and costs. The prosecution arose out of an accident (No. 8, *see* page 43 and Appendix W.) by which three persons were injured, caused by the explosion of a filled shell which had been sold as old metal.

Conveyance by road.

The conveyance of explosives by road is now, *so far as we have observed*, generally conducted in accordance with the requirements of the law.

But, as we have remarked in former Reports, this is a point which we have, for obvious reasons, very little opportunity of personally observing, and is one for which the Local Authorities must be practically considered as solely responsible. It is of course possible that many offences against the salutary provisions of the Act in this respect are committed and not detected, but we have reason to believe that, owing to the increased vigilance of the Local Authorities, at all events in districts where explosives are largely conveyed, the chances of detection are considerably greater than formerly.

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* *See* p. 23. † *See* p. 3.

The only cases of illegal conveyance which have come under our notice during the year are as follows :— Cases of illegal conveyance.

Messrs. Bridges and Forss were convicted and fined 27*l.* 10*s.* and costs, for offences in connexion with the conveyance of explosives on the Thames in the powder boat "Superb." The particulars will be found in Appendix T(*b*).

Mr. Thompson, a chemist, was conveying coloured fires surreptitiously, in a first-class carriage on the Manchester, Sheffield, and Lincolnshire Railway, when they ignited spontaneously, injuring himself and two other persons. In consequence of the injuries sustained by him the railway company did not institute proceedings for the offence. (*See* Accident 87, Appendix W.)

In respect also of railways (and docks worked by railway companies) the 1876 code of byelaws remains unaltered. Carriage by railway.

There are now 119 railways (and docks worked by railway companies) under this code.

The number of railways and docks worked by railway companies on which explosives are prohibited is now 17, two docks (Chelsea and West Hartlepool), having been added to the list of places in which there is no traffic in explosives.

For details as to the railways, &c. carrying and not carrying explosives, *see* Appendix G.

The code of byelaws for canals, which was approved by the Board of Trade in 1876, and quoted in our Annual Report for that year, is still in force, and we have seen no reason for suggesting any alteration in the same. Canals

The number of canals working under these regulations is now 109, the Droitwich Junction Canal having been added during the year.

The number of canals which have given notice that they do not carry explosives remains at 11, as since 1876. For details as to canals carrying and not carrying explosives, *see* Appendix H.

At the date of our last Report, 275 harbours and docks were returned as provided for. Harbours and docks.

Of this number, 48 had no trade in explosives, or had prohibited under former Acts, and 70 had prohibited under the Explosives Act, 1875.

General byelaws regulating traffic in explosives have been sanctioned by the Board of Trade for Westport, and *additional* byelaws for Leith have also been sanctioned during the year, the former port has consequently been transferred from the list of those in which no traffic in explosives exists, to that in which a general traffic is provided for.

There are, therefore, 135 harbours and docks where a general traffic is provided for; and in 23 cases a limited traffic is provided for. The number of harbours and docks where no traffic in explosives exists is 47; that of the harbours and docks in which such traffic is absolutely prohibited under the Explosives Act, 1875, is 70. Thus a total of 275 harbours and docks is provided for in one way or another. This number comprehends nearly the whole of the harbours of importance. For details, *see* Appendix I.

The following table shows in a synoptical form the condition of the railways, canals, harbours, and docks, in regard to the making of byelaws :—

—	Number of Companies, Harbours, and Docks which have made Byelaws regulating the Traffic in Explosives (including those which allow of a limited Traffic).			Number of Companies, Harbours, and Docks which have notified that they either will not admit a Traffic in Explosives or have no such Traffic.		
	Railways.	Canals.	Harbours and Docks.	Railways.	Canals.	Harbours and Docks.
England - - - -	75	97	85	16	9	36
Scotland - - - -	19	3	25	—	1	63
Ireland - - - -	25	9	48	1	1	18
Total - -	119	109	158	17	11	117

As we have remarked in previous Reports, these figures appear to us to afford a perfectly satisfactory answer to the anticipations which were expressed by some of the

trade when the Act first came into operation, that the effect of the restrictive regulations would be to deter the railways and canals generally from carrying explosives, and to close the harbours against this class of goods.

Accidents in conveyance.

Two accidents occurred during the year in the conveyance of explosives. (*See* Accidents Nos. 87 and 94, page 35, and Appendix W.)

IV.

Importation.

In accordance with the regulation referred to at page 13 of our Report for 1890, importation licenses are now valid for one importation only, and more recently it has been decided that the duration of all such licenses shall be limited to six months. The importation of the consignment for which the license was obtained must therefore be effected within that period.

The number of licenses granted during 1893 was 88, as compared with 150 granted in 1892 and 135 in 1891.

Nitro-glycerine compounds.

The amount of foreign nitro-glycerine compounds suitable for blasting purposes imported during the year was as follows :—

——	Lbs.
Dynamite	24,200
Gelatine dynamite	400,050
Matagnite gelatine	16,350
Carbonite	136,350
	576,950

This is a very large decrease on 1892, in which the total of these compounds imported amounted to 850,000 lbs., and is a still larger decrease on the average of previous years.

It will be observed that dynamite has fallen from 226,398 lbs. to 24,200, or nearly 90 per cent.; gelatine dynamite from 439,700 lbs. to 400,050 lbs., or about 9 per cent.; matagnite gelatine from 50,350 lbs. to 16,350 lbs., or about 68 per cent.; while blasting gelatine has disappeared from the list altogether. Carbonite shows a very slight decrease. Whether this very great falling off in the importation of these compounds has been brought about by increased home production, by the gradual disfavour into which dynamite has fallen, and the difficulty experienced by some foreign makers in producing gelatinous preparations up to the high standard of quality insisted on in this country, or by reduced consumption in consequence of the recent coal strike, and other trade disturbances, or perhaps by all these causes combined, it is, of course, impossible to say. It may be interesting to place on record the amounts of nitro-glycerine explosives imported for blasting purposes during the previous ten years, which were as follows :—

——	Lbs.	——	Lbs.
1883	1,920,650	1888	1,120,800
1884	1,085,000	1889	1,325,950
1885	1,068,100	1890	899,652
1886	1,073,500	1891	734,100
1887	707,500	1892	856,668

Detonators

The very large number of detonators imported during the year (viz., 7,179,000 in addition to six cases, number of detonators not stated) is in excess of the number imported in 1892 (viz., 6,753,000), and shows that a great percentage of this trade remains, as hitherto, in foreign hands. It will be seen, however, from Appendix B. that there are seven factories in this country in which these indispensable adjuncts to the use of high explosives can be made.

Fireworks.

The number of fireworks and toy fireworks imported is about the same as last year, and is so large as to excite surprise.

The details of all the importations made during the year will be found in Appendix J. With the above exceptions they call for no special remarks. Appendix K shows the number of licenses granted for each nature of explosive during the year.

As explained in previous Reports, a considerable amount of imported explosive is not really for home consumption, but is simply brought into this country for re-shipment abroad. Such a transaction has to be covered by an importation license, but we have not thought it necessary to attempt to ascertain exactly what proportion is so re-exported, and what proportion finds its way into the English market. Every cargo brought into English waters is sampled and examined and otherwise treated exactly as if it were for home consumption, and we take no note of its actual destination.*

Irregularities in the importation of explosives.

Five cases of illegal importation of amorces have been dealt with by Her Majesty's Customs.

There were six cases of illegal importations of fireworks, as follows:—

(1.) Ex "Teucer" at London, March 1893, 23 cases of Japanese "shells" were imported as "Curios." No license being produced, the Customs confiscated the goods. They were afterwards sold to Messrs. Pain and Sons.

(2.) Messrs. Sanders Rehders & Co. in October imported a case of "fire crackers" without a license. The Customs seized and destroyed the case.

(3.) Crackers imported at Harwich in October without license were seized and destroyed by Customs.

(4.) Messrs. Richter, Tschuschner, & Co. imported a case of Cosaques. The Customs seized it, failing production of a license, but the goods were ultimately released.

(5.) Messrs. Langstaff, Ehrenberg, and Pollak imported into Liverpool, for transmission to Porto Rico, 11 cases of fireworks. The firm was prosecuted (*see* Appendix T(*b*)) and they eventually obtained an importation license for the goods.

(6.) Twenty cases of star rain matches were consigned to Messrs. Brock & Co., who refused to accept delivery, since they were sold to them as aluminium or Bengal safety matches. The Customs were informed that the matches should either be destroyed or allowed, with infliction of a small fine, to be re-exported.

On the 17th June 1893, a small quantity of a substance supposed to be rendrock, was found in the baggage of a passenger on board the "Umbria" from New York to Liverpool. On examination it proved to be a mixture of potassium chlorate and oxide of iron.

In August 1893 the Norwegian Government sent Messrs. Kynoch & Co., a small quantity of smokeless powder for testing purposes. The Middlesbro' Customs seized it. The company declined to receive it, and requested their shipping agents to return it to the sender.

On 5th December 1893 an irregular importation of damaged safety cartridges occurred at Gloucester, the cartridges being described as old metal. They were seized, and were recommended to be destroyed by being sunk in deep water.

Mr. J. R. Watson in March imported under License 410*a*, 200 pounds Cooppal's powder, coloured with aniline dye. It was placed under seizure by us, but in the end allowed to be returned to port of origin.

Mr. J. R. Watson also imported under License 426*a*, 16,350 pounds of matagnite gelatine, which, on examination, proved defective, but not sufficiently so to necessitate it being sent back. The repeated failure of samples of consignments of this explosive to pass the tests, has raised the question whether any more licenses for it should be granted.

Mr. R. C. Briscoe in February imported under Licenses 406*a*, and 407*a*, 22,500 pounds of gelatine dynamite No. 2 into Conway. The samples taken failed to pass the tests (exudation), and proceedings were instituted against Mr. Briscoe, and penalties were inflicted amounting to 25*l*., and 13*l*. 9*s*. 3*d*. costs. The explosive was allowed to be returned to the manufacturers. (*See* Appendix T(*a*).)

* As to the different policy which prevails in Germany, where dynamite not of German manufacture is forbidden to be carried by the State Railways, *see* note on p. 23, Annual Report for 1885.

Messrs. Joest van Heel & Co. obtained a license to import amorces. The explosive was found to differ from that allowed by the license, and the consignment was ordered to be either destroyed or returned to the manufacturers.

Ports for which importation licenses are granted.

Importation licenses, as explained in former Reports, are only granted (*a*) for those ports for which byelaws regulating a general trade in explosives have been duly made under the Act; and (*b*) where, in the opinion of Her Majesty's Commissioners of Customs, the duties of sampling cargoes devolving on the Customs officers can be conveniently discharged; and (*c*), in Ireland, those which are named in Orders made under the Peace Preservation (Ireland) Act, 1881, as ports into which explosive may be brought.*

A list of the ports in England, Wales, and Scotland for which importation licenses can at present be granted is given in Appendix L(*a*.). The number of these remains the same as at the end of 1888, viz., 33. The Appendix also includes a list of the ports in Ireland which are specified in the Orders under the Peace Preservation Act as those into which explosives, not requiring a license under the Act, may be brought.

Importations of gunpowder.

As the importation of gunpowder does not require a license, we receive no notice of any such importations; but the Statistical Department of the Board of Trade has been good enough to furnish us with information as to the importations of gunpowder which took place during the year, and this we have added to information derived from the same source and published in our Report for 1890; the figures thus collected show the transactions in the import of gunpowder from 1870 to 1893 inclusive. (*See* Appendix L(*b*).)

We have also appended tables showing the quantity and value of gunpowder exported from the United Kingdom during the same period, distinguishing that of British manufacture from that of foreign and colonial manufacture. (*See* Appendices L(*c*), L(*d*).)

V.

Government Inspection and Search.

We have seen no reason to modify the opinion we have expressed in former Reports, to the effect that the powers conferred on Government Inspectors by section 55, coupled with the powers of search and seizure conferred by sections 73, 74, and 75, are ample and satisfactory.

Proceedings instituted by Government Inspectors.

We have felt it necessary to institute proceedings in five cases, but, as stated under the head of manufacture, in one case the prosecution was abandoned, on the defendant surrendering his license and giving up his factory. There were thus four cases taken into court, which is below the average (8·2 per annum) for the previous 17 years from 1876 to the end of 1892, during which period we took proceedings in 140 cases. Convictions were obtained against all the four offenders, and fines amounting to 145*l.* were inflicted, in addition to costs. The particulars of these cases are given in Appendix T(*a*).

Proceedings instituted by Local Authorities on motion of Government Inspectors.

In addition to the above, proceedings have been taken by the Local Authorities on our motion, or on information supplied by us, in 14 cases, the particulars and results of which are given in Appendix T(*b*). This is below the average of former years. Thus, there were 27 such cases in 1884, 26 in 1885, 22 in 1886, 11 in 1887, 46 in 1888, 18 in 1889, 6 in 1890, 15 in 1891, and 19 in 1892.

In procuring the institution of proceedings by the Local Authorities or their officers we have been influenced by the considerations set forth in former Reports, which it is unnecessary to repeat here.

Seizure of explosives.

In addition to the cases in which we initiated the institution of proceedings of one sort or another, there were five cases in which explosive was placed by us, or at our instance, under seizure, in four of which it was afterwards released without further action. (*See* Appendix U.)

* It should be particularly observed that it does not follow that all the Irish ports named in this list would be licensed for the importation of explosive, because some of them may not satisfy the conditions (*a*) and (*b*) specified in the text. A new Order has been made by the Lord-Lieutenant under the Peace Preservation Acts, dated 24th February 1893, relative to the Importation of Arms and Ammunition, and naming the following as the only ports into which Arms and Ammunition may be imported:—"Dublin, Belfast, Cork, " Limerick, Londonderry, Waterford, Galway, Sligo, Drogheda, Dundalk, Greenore, Newry, Wexford, Larne, " Carrickfergus, Glenarm, and Westport (Quay)." The expression ammunition is defined to mean:—" Bullets, " gunpowder, nitro-glycerine, dynamite, gun-cotton, and every other explosive substance, whether fitted for " use with any arms or otherwise."

The total number of cases of seizure of all sorts in which we were concerned was 8, the average for the previous 10 years being 34·2. But the increase is not entirely due to improvement, as the number of our inspections during the year is less than the average for these years.

The following table gives the nature and amount of work in the way of inspections and other visits which we have accomplished during the year, and for convenience of comparison we have shown in italics the work performed in the 17 preceding years since the Act came into operation. Extent of inspectorial work accomplished during the year.

Detailed Return of Inspections and other Visits from 1st January 1876 to 31st December 1893.

—	Factories.	Magazines.	Stores.	Small Firework Factories.	Registered Premises.	Places not classed.	Sites.	Inquests.	Inquiries.	Local Authorities.	Miscellaneous.	Total.
In 1893 -	205	406	42	10	134	—	—	5	4	3	45	854
In 1892 -	*250*	*439*	*121*	*8*	*200*	*1*	—	*2*	*6*	*77*	*99*	*1,202*
In 1891 -	*254*	*401*	*89*	*8*	*282*	*1*	*1*	—	*1*	*94*	*80*	*1,211*
In 1890 -	*224*	*431*	*196*	*6*	*185*	*2*	—	*5*	*5*	*91*	*112*	*1,257*
In 1889 -	*197*	*431*	*191*	*9*	*299*	*5*	*3*	*3*	*3*	*132*	*141*	*1,414*
In 1888 -	*168*	*367*	*300*	*7*	*483*	*11*	—	*2*	*4*	*252*	*200*	*1,794*
In 1887 -	*235*	*448*	*232*	*26*	*302*	*7*	—	*8*	*7*	*130*	*184*	*1,579*
In 1886 -	*216*	*452*	*206*	*5*	*283*	*4*	*3*	*6*	*4*	*135*	*118*	*1,432*
In 1885 -	*170*	*417*	*275*	*7*	*392*	*15*	*2*	*7*	*4*	*138*	*200*	*1,627*
In 1884 -	*155*	*389*	*284*	*10*	*349*	*15*	—	*7*	*10*	*124*	*234*	*1,577*
In 1883 -	*139*	*345*	*215*	*6*	*319*	*14*	*3*	*8*	*10*	*134*	*198*	*1,391*
In 1882 -	*111*	*329*	*368*	*6*	*224*	*16*	*2*	*7*	*9*	*54*	*201*	*1,327*
In 1881 -	*107*	*163*	*192*	*6*	*89*	*2*	—	*6*	*7*	*83*	*191*	*846*
In 1880 -	*102*	*316*	*288*	*2*	*75*	*29*	—	*3*	*3*	*137*	*159*	*1,114*
In 1879 -	*91*	*220*	*319*	*8*	*43*	*16*	*2*	*8*	*9*	*99*	*169*	*984*
In 1878 -	*80*	*142*	*210*	*8*	*38*	*46*	*10*	*8*	*7*	*99*	*152*	*800*
In 1877 -	*57*	*215*	*215*	*9*	*17*	*117*	*7*	*8*	*6*	*241*	*101*	*993*
In 1876 -	*40*	*72*	*39*	*4*	*11*	*88*	*15*	*14*	*8*	*88*	*78*	*457*

As explained in the introductory portion of this Report (*see* page 3) the work of inspection has been much broken in upon during the year, and cannot be compared with that of former years, owing to the illness and subsequent retirement of Colonel Cundill. We have, however, managed to inspect every factory and magazine on our books at least once, and, in some cases, more than once. The number of our visits to the Local Authorities and the stores and registered premises, on the other hand, has been necessarily very much reduced.

No lectures to the local officers have been given by us during the year.

In the course of our duties we have necessarily travelled over a good deal of ground, and on reference to our books we find that— Ground covered during our inspections. Counties.

Of the 52 counties of England and Wales, we have visited 40
„ 33 „ Scotland, we have visited 16
„ 32 „ Ireland „ 7

Making a total out of the 117 counties in the United Kingdom of - - - - - 63

in which we have made inspections and paid visits of various sorts during the year. (*See* Appendix M.) Of the unvisited counties the large proportion are agricultural counties where explosive is comparatively little used or kept.

Appendix N. enumerates the various boroughs and urban sanitary authorities which we have personally visited since the Act came into force, with a view to conferring with and assisting the Local Authority, or otherwise making observations as to the working of the Act therein. Boroughs.

The total number of boroughs so visited now amounts to 290.

We have continued to have the benefit of the valuable services and extensive experience of Dr. Dupré, F.R.S., as the chemical adviser of the Department; and in accordance with our practice we submit *in extenso* that gentleman's report on the work which he has done for us during the year. Chemical work of the Department.

Westminster Hospital Medical School,
Caxton Street, S.W., December 31st, 1893.

Gentlemen,

The changes, indicated in three preceding Reports, in the character of the explosives chiefly examined, still continue, that is, the samples of gelatine dynamite, particularly those of gelatine dynamite No. 2, predominate more and more, while

dynamite No. 1 now holds comparatively quite a subordinate position. The quality of the samples examined was not quite of such uniformly good character as during some of the preceding years. Thus, while last year the rejected samples amounted to 18 out of a total of 320, or 1 in 17 nearly, this year they amounted to 18 out of a total of 227, or about 1 in 12. This unfavourable proportion is, however, due entirely to a number of defective samples of gelatine dynamite No. 2 imported from a single foreign factory. The condition of all other explosives was highly satisfactory.

The various samples of articles examined are, as usual, given in two tables. Table I. contains all samples of licensed explosives, or of materials used in the manufacture of such explosives; Table II. contains all articles examined which do not fall under either of these heads.

The total number of articles included in the two tables amounted to 271, a diminution of 80, as compared with last year. In addition to the samples chemically examined, 27 other samples passed through my hands, but were examined only in regard to their physical condition, which in all cases but two was found to be satisfactory.

TABLE I.

Nature of Substance.	No. of Samples.		
	Passed.*	Rejected.	Total.
Amberite	3	—	3
Ammonite	3	—	3
Amorces	1	—	1
Ballistite	16	—	16
Bellite	13	—	13
Blasting gelatine	2	1	3
Carbonite	23	—	23
Cannonite No. 2	1	—	1
Chinese crackers	1	—	1
Cocoa powder	1	—	1
Cooppal's powder	9	2	11
Denaby powder	1	—	1
Di-nitro naphthaline	1	—	1
Dynamite No. 1	13	—	13
E. C. powder	2	—	2
Fortisine	5	—	5
Fortis	1	—	1
Gelatine dynamite No. 1	14	—	14
„ „ No. 2	47	14	61
Grasshopper composition	1	—	1
Guncotton	1	—	1
Gunpowder	5	—	5
Igniting tapes	5	1	6
Nitro cotton	1	—	1
Nitro-glycerine	2	—	2
Oarite	1	—	1
Rain composition	1	—	1
Roman candle	1	—	1
Saltpetre	3	—	3
Schultze powder	1	—	1
Securite	1	—	1
Smokeless powders:—			
Blasting powder No. 2	1	—	1
B.M.	1	—	1
Chilworth	4	—	4
Walsrode powder	11	—	11
S.S.	5	—	5
Squib composition	1	—	1
Stars, coloured	1	2	3
Stonite	1	—	1
Tonite No. 1	1	—	1
„ No. 2	1	—	1
Total	207	20	227

* Under the heading "Passed" are given, in the first place, the number of samples of the various explosives, the exact nature of which is defined in the license under which they are manufactured, and which were found to comply with the conditions thus laid down; and in the second place, the number of such other explosives or substances used in the manufacture of explosives, &c., &c., the nature of which is not specifically fixed by license, which were found free from any dangerous or objectionable features. Under the heading "Rejected" are given the number of samples found violating the terms of their license, or containing some dangerous ingredient; for example, coloured fires, or fireworks containing a substance which would render them liable to spontaneous ignition.

TABLE II.

Nature of Substance.	Number.
Alloy of potassium and sodium	1
Chlorate of potassium	5
Chlorate mixture	1
Débris	9
Detonator	3
Drain tester, composition for	1
Magnesium powder	1
„ and chlorate mixture	1
Safety fuze	2
Smoke rocket	1
„ „ residue from	1
Sodium peroxide	2
Miscellaneous	16
Total	44

The condition of the various explosives examined during the year, which are given in Table I., was, with one notable exception (gelatine dynamite No. 2), satisfactory. Out of a total of 227 articles examined, 18 have been rejected, or a little over 8 per cent., a proportion which is higher than it has been for some years past.

Amorces.—The importation of these toys has apparently practically ceased, and only one sample has been examined during the year.

Dynamite.—The 13 samples of dynamite examined were all highly satisfactory as regards chemical purity. Several of these, however, showed a rather high proportion of kieselguhr which, as I have pointed out in previous reports, is a defect which may lead to accidents in the use of such dynamite, inasmuch as it is less readily and completely detonated, and either does not explode at all, or gives off noxious vapours.

Blasting Gelatine.—This explosive is, so far as our observation goes, rapidly being superseded by other gelatinized preparations, and three samples only have been examined during the year, of which one had to be rejected on account of not standing the heat test.

Gelatine Dynamite.—The two varieties of this explosive occupy, as they did last year, the first place among the various explosives examined as regards number of samples, and the preponderance of gelatine dynamite No. 2 (gelignite) is still more marked than it was last year. Unfortunately the quality has not kept up to the proper standard. The defects observed are confined, practically exclusively, to exudation, which in some of the samples reached a dangerous degree. It is not easy to imagine why gelatine dynamite No. 2 should have shown a tendency to exudation so much greater than No. 1, in spite of the fact that in the former there is a far greater proportion of absorbent material than in the latter. Possibly it is this fact which makes manufacturers less careful in the production of their gelatine than they otherwise would be. In addition to this, the production of a nitro-cotton of the requisite character, not only to gelatinize the nitro-glycerine, but to prevent separation of nitro-glycerine in time, is by no means fully understood even yet, and every manufacturer has to work it out for himself. In consequence of this, almost every new manufacture is found more or less defective. Although three only out of 78 samples of gelatinized preparations examined failed to pass the heat test, a far larger number came very near to the limit. It may, therefore, be well to repeat a warning of former years, viz., that both the nitro-cotton and the nitro-glycerine which are to be used in the manufacture of gelatinized preparations should be purified to a greater degree, *i.e.*, made to stand the heat test for a longer time, than that laid down for these preparations when used by themselves. That is, a gelatinized preparation, made from nitro-cotton and nitro-glycerine, either of which will just pass the heat test, will not itself pass the test.

Walsrode Powder.—All the 11 samples of this powder examined were of satisfactory character.

Cooppal's Powder.—Eleven samples of this powder have been examined during the year, of which two had to be rejected, not on account of any defect in their stability,

but because they had been coloured with a colouring matter the use of which had not been licensed. There has been some correspondence with the company regarding the question of licensing such a powder, but as yet the company have not submitted any samples.

Igniting Tapes.—In my last year's report it was stated that the fashion for these tapes, which was at its height early in 1892, had begun to wane towards the end of the year. This year there is a considerable falling off, only six samples having been examined, of which one was rejected as it was manufactured in a manner and from ingredients which had not been licensed.

Fireworks.—Several accidents bearing on the question of the composition of fireworks have occurred during the year. In one case, by an unfortunate accident, chlorate of potassium had been substituted in place of nitre in a "smoke rocket" composition, which in consequence became far more sensitive to percussion and friction, and thus led to an accident. In another case, some coloured stars ignited, probably spontaneously, which had contained both sulphur and chlorate of potassium, a combination which, as I have frequently pointed out, is extremely liable to spontaneous ignition, particularly when impure or acid sulphur is used; and the danger is present even when thoroughly washed sulphur only is employed. I may be allowed to express my satisfaction at the steps taken by your Department to diminish this risk for the future.*

All the other explosives examined were in a satisfactory condition.

New Explosives examined during the year.

Five new samples of smokeless powder were submitted during the year, of which two have been reported on, and three are still under examination.

Westfalite.—This is a mixture of nitrate of ammonium and gum lac, and was favourably reported on.

Von Forster's Powder.—This is a pure nitro-cellulose powder, thoroughly gelatinized, and containing a small proportion of chalk. It was favourably reported on.

Schnebelite.—This explosive is another attempt to render chlorate of potassium available as a constituent of an explosive. The sample was only submitted to a preliminary testing, which it stood satisfactorily. The sample submitted contained a relatively small percentage of chlorate, and it remains to be seen whether such a powder will stand the more searching test to which it is now being submitted.

Electric Low-tension Fuze Composition.—Several additions to his electric low-tension fuze were proposed by Mr. Brain, and, after examination, favourably reported on.

A new composition for an electric low-tension fuze was submitted by Mr. Whatley, but reported against on account of chemical instability. A second composition afterwards submitted by the same was favourably reported on.

Igniting Tapes.—An igniting tape, in which the dots of composition were not covered by paper, was submitted by Mr. Cadwell, and unfavourably reported on as being too sensitive to friction, and liable to explosion *en masse*.

Candle Crackers.—Mr. Dowles submitted a toy called a magic candle pin cracker, which is merely a cracker attached to a small pin for blowing out a candle. They were found to be small, and not liable to go off *en masse*, and favourably reported on, provided certain conditions as to packing were complied with.

Carbonite, packing of.—Application was made during the year to allow carbonite to be packed in non-waterproof packing, and as careful experiments showed that carbonite, as licensed, even when entirely submerged in water, and at the same time subjected to slight pressure, did not allow any nitro-glycerine to escape, the application was favourably reported on.†

Troisdorf Powder, change in name of.—In the course of the year the name of the explosive known as Troisdorf Powder was changed to that of Chilworth Smokeless Powder.

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* On this point, *see* p. 33.

† As, however, the prevention of the escape of wood-meal saturated with nitro-glycerine presented practical difficulties, effect has not been given to this recommendation pending the adoption of suitable means for dealing with this point.

Explosion at Dublin.

The examination of the débris found in the small crater formed in a granite slab at Exchange Court, Dublin, caused by the explosion in which Detective Sinnott unhappily lost his life, showed the presence of strong traces of chlorides and nitrates. For a time I thought that these facts pointed rather strongly to the nature of the explosive used. On procuring, however, part of the unbroken slab of granite a little away from the crater, I found even in the interior of large pieces, carefully washed on the outside, the same traces of nitrates and chlorides, and it became clear that their presence in the débris from the crater, could not be taken as revealing the nature of the explosive employed, but that their presence was due to other causes.

Experiments.

In consequence of an explosion which happened at the Whitecross Street Goods Station of the Midland Railway, caused undoubtedly by some peroxide of sodium present in a box at the station, a series of experiments was undertaken to ascertain how such an explosion could have originated. These experiments clearly demonstrated that peroxide of sodium by itself is a perfectly stable body, not liable to spontaneous decomposition, and not liable to explode by percussion, friction, heat, or by the addition of water, although in the latter case much heat is evolved and steam produced. When, however, the peroxide is mixed with, or even simply in contact with, any combustible substance, it becomes a highly dangerous material, inasmuch as, under these circumstances, the access of water to the mixture causes the almost instantaneous outbreak of fire, or causes an explosion according to the greater or less intimacy of the mixture. The precautions suggested by this explosion, fortunately unattended with loss of life or serious damage to property, are obvious.

Peroxide of sodium should always be packed in a strong metallic case, not liable to injury during transport, and all contact, or possibility of contact, with any combustible matters, carefully avoided.

Explosion at Eastbourne.

An explosion at a theatre in Eastbourne drew attention to the dangerous nature of the mixture of powdered magnesium and chlorate of potassium used for the production of lightning. Such a mixture, although but slightly sensitive to percussion, was found to be an extremely violent explosive, and obviously great care should be taken in its use. It might be advisable to try whether ordinary magnesium flash lamps, in which powdered magnesium only is employed, might not be used in place of the dangerous chlorate mixture, although the flash they produce has not perhaps quite the intensity of that of the chlorate mixture.

Wood Meal in Gelatine Dynamite.

Several communications received from Mr. Hake from Australia seemed to show that certain manufactures of gelatine dynamite suffered considerably, as regards their stability, during their passage from England. A series of experiments has therefore been started to throw, if possible, light on the causes of this deterioration. The experiments are still in progress, and I am not as yet in a position to report. I cannot, however, let the opportunity pass without expressing my best thanks to the Nobel's Explosives Co., of Glasgow, and Mr. O. Guttmann, of London, for the readiness with which they complied with my request to furnish me with the samples necessary for such an investigation.

I remain, Gentlemen,
Your obedient Servant,
A. Dupré.

To Her Majesty's Inspectors of Explosives,
Home Office, Whitehall.

VI.

Working of the Act by the Local Authorities.

Working of the Act by the Local Authorities.

Owing to the cause already stated, we have been unable to devote much attention to the working of the Act by the local authorities during the year. We have, however, visited 10 small firework factories, 42 stores, and 134 registered premises, and thus have been enabled to ascertain the general condition of these places in some districts.

We have in past reports entered very fully into the considerations affecting this branch of our work. We have but little to add to what has been said before. On the whole, there has been a steady improvement in the condition of the stores, and in some of the mining districts they are extremely well looked after. As always, the registered premises form the most troublesome branch of our inspectorial duties; their number, their universal distribution, and, we must add, the extreme ignorance (real or feigned) of the occupiers, in many cases render it difficult for us to make much impression on them as a mass. Still, we can report that they are better looked after as a whole by the local officers than formerly, and that it is exceptional now to find large excesses of explosives stored on them. We find it useful, in the case of glaring irregularities, to cause the local officer to lay informations, and one or two convictions frequently have the good effect of stirring up to increased care, not only the occupiers in the borough or district, but also the local officers themselves.

So far as our observations have gone during the past and preceding years, the following may be enumerated as among the more important districts and places in which an attentive and intelligent administration of the Act prevails:—Aberdeenshire, Argyll, Ayr, Cardigan, Carnarvon, Cornwall, Cumberland, Denbigh, Derby (parts of, especially the Repton and Gresley district), Devon (part of), Dumbarton, Durham (parts of), Edinburgh, Fife, Glamorgan, Inverness, Merioneth, Nottingham (part of), Lancashire, (parts of, especially the Furness district), Leicester, Linlithgow, Lanark, Pembroke, Somerset (parts of, especially the Radstock district), Stafford (parts of), Stirling, Sussex, Warwick (parts of, especially the Nuneaton district), Westmorland, Yorkshire (parts of, especially the Cleveland district), and among the cities and boroughs, the Metropolis (especially that part of it which is under the control of the London County Council), Bath, Birmingham, Edinburgh, Glasgow, Huddersfield, Leicester, Liverpool, Portsmouth, Manchester, Newcastle-on-Tyne, Nottingham, and Sheffield.

Other places, of which we have not had personal experience, might, perhaps, be added, and we hope that we shall find on revisiting places originally defective, to which we have not been for some years, that our former visits have borne fruit, and that substantial advance has been made.

Ireland.

The number of rural sanitary districts in which officers of the Royal Irish Constabulary are employed as local officers under the Act according to our last Return was 152 as against about 120 in 1886. This increase is of course satisfactory.

The number of districts in which officers other than those of the Royal Irish Constabulary are appointed was 271, and in 185 no officers whatever were appointed.

We have not obtained any further Return on these points during the past year.

Measures adopted for improving the administration of the Act by the Local Authorities.

We may here recapitulate the measures to which we habitually have recourse for procuring an effective administration of the Act by the Local Authorities, viz.:—

(1.) Visits to the Local Authorities as the time and opportunities for such visits may present themselves. We have, as stated, paid 36 of such visits during the year, and 2,144 during the 18 years that the Act has been in operation.

(2.) Explanatory lectures on the Act to the assembled officers of the Local Authorities. During the past year, however, we have not delivered any such lectures.

(3.) Inspection (where practicable in company with the officer of Local Authority) of Stores, Registered Premises, and Small Firework Factories, taken at random in the different districts in which we may be engaged. As already stated, we paid during the year 42 visits to stores, 134 to registered premises, and 10 to small firework factories.

Guide Book.

(4.) The Guide Book to the Act, which we prepared for the use of the Local Authorities, continues, we believe, to prove of very substantial assistance to those authorities and their officers, and is generally recognised as indispensable

to the proper working of the Act. The seventh edition of this Guide Book has now been issued.

According to a return furnished by the Controller of H.M. Stationery Office, the number of copies of the Guide Book sold and supplied during the year was 347, making a total of 7,868 copies sold and supplied of this publication of all editions, the seventh edition being now on sale. Local Government Acts.

In our report for 1890 we gave at some length the changes introduced into the Local Authorities by the Local Government Acts, 1888 and 1889, for England, Wales, and Scotland. We reprint here a table showing the old and new state of things in both countries.

LOCAL AUTHORITIES.

ENGLAND AND WALES.		SCOTLAND.	
As under Explosives Act, 1875.	As under Local Government Act, 1888.	As under Explosives Act, 1875.	As under Local Government Act, 1889.
1. In the city of London, except as hereafter mentioned, the court of the lord mayor and aldermen of the said city.	1. As before (section 41).	1. In any borough, the magistrates and town council.	1. As before.
		2. In any harbour, as for (4) in England and Wales.	2. As before.
2. In the metropolis (that is, in places for the time being within the jurisdiction of the Metropolitan Board of Works under the Metropolis Management Act, 1855), except the city of London, and except as hereafter mentioned, the Metropolitan Board of Works.	2. London County Council replaces Metropolitan Board of Works.	3. In any place other than a borough or harbour as aforesaid, the justices of the peace for the county in which such place is situated.	3. The powers vested in the county justices pass to the county council without power of delegation.
3. In any borough in England which is not assessed to the county rate of any county by the justices of such county except as hereafter mentioned, the mayor, aldermen, and burgesses acting by the council.	3. As before as regards county boroughs and quarter sessions boroughs of over 10,000 inhabitants. Also boroughs of over 10,000 inhabitants created local authorities under section 68 of Explosives Act, but not boroughs of less than 10,000 inhabitants.		
4. In any harbour within the jurisdiction of a harbour authority, whether situate or not within the jurisdiction of any local authority before in this section mentioned, the harbour authority, to the exclusion of any other local authority.	4. As before.		
5. In any place where there is no local authority as above defined, the justices in petty sessions assembled.	5. The powers vested in the justices pass to county council with power of delegation to— (*a.*) A committee of its own body. (*b.*) To any district council, interpreted by section 100 to mean a rural or urban sanitary authority, until establishment of such district council by future Act of Parliament. (*c.*) To the justices of the county assembled in petty sessions.		

To aid the new bodies in their functions of granting licenses, &c., a memorandum was prepared for the Scottish county councils (at the request of the Office of the Secretary of State for Scotland), of which a copy was given in our last year's Report, and being useful for reference is here repeated. It is really applicable to the whole of the United Kingdom.

MEMORANDUM on the LOCAL ADMINISTRATION of the EXPLOSIVES ACT, 1875.

In making provision for the local administration of the Explosives Act, regard must be had to various classes of requirements and conditions arising under the Act:

Factory and magazine licenses.

(1.) There is the case of a trader who desires to establish a new factory or magazine (sections 6, 7, 8, 39), and who has for this purpose to obtain the assent of the local authority to a draft license issued by the Secretary of State. The procedure in this case must be as directed by section 7 of the Act; and it involves the publication by the applicant of a notice of the time and place appointed for the hearing not less than one month before such hearing; and the Statute further requires the local authority to fix the time and place of hearing as soon as practicable after application has been made to them, and the time so fixed must be as soon as practicable after the expiration of the said month from the publication and service of the notices, and the final decision must be given by the local authority as soon as practicable after the expiration of the said month.

Store licenses.

Then there is the case of the trader who desires to obtain a license for a store (sections 15, 39).

In such a case no formal hearing is necessary. The grant of a store license ("as soon as practicable") is compulsory, if the proposed site, construction of the store, and amount of explosive to be stored therein are in accordance with the Orders in Council on the subject.

The necessary machinery for ascertaining these points requires therefore to be provided and would generally be forthcoming in the officers appointed by the local authority under the Act. (Section 69.)

Renewal of store licenses.

(3.) Then there is the case of the annual renewal of store licenses (sections 18, 39). Such renewal also is compulsory unless the circumstances have so changed as to invalidate the license, and no formal hearing is necessary for this purpose.* The machinery provided to deal with original store licenses would of course be adequate for renewals.

Registration of premises and renewal of registrations.

(4.) Then there is the case of the trader who desires to "register" his premises for the keeping of explosive, or to renew such registration. (Sections 21, 39.) Here again no formal hearing is necessary, the less so, as there is no power to refuse a registration or renewal. It rests with the local authority on receipt of a notice to register (or renew), with the necessary fee, to effect the required registration (28) and thus to open the premises to inspection. (Section 68.) Such notice, it is obvious, may very well be sent by post; indeed, the Act distinctly indicates in the case of renewals that the notice may be sent "by post or otherwise."*

Inspectorial and other duties.

(5.) Lastly, provision has to be made for the efficient local administration of the Act (section 69) by the appointment of officers (sections 69, 75), and the carrying out by them of the necessary inspections and search (sections 69, 73, 74, 75); the taking of samples (sections 69, 75, 76), and other duties of observation, inquiry, and report.

The official guide book to the Explosives Act, which is published by Her Majesty's Stationery Office, gives all necessary information as to the duties devolving on local authorities and their officers under the Act.

(Signed) V. D. MAJENDIE,
Colonel,
H.M. Chief Inspector of Explosives.

Home Office,
1st August 1890.

During the year the question has received consideration whether the effect of the 38th section of the Burgh Police (Scotland) Act, 1892, is to transfer the local jurisdiction under the Explosives Act, 1875, in certain burghs from the county council (in which it became vested by the Local Government (Scotland) Act of 1889), to the magistrates and commissioners of such burghs.

* The renewals can be simplified by the local authority arranging for them all to be effected on one date.

The 38th section of the Burgh Police (Scotland) Act of 1892, directs that "The "magistrates and commissioners elected in virtue of this Act, shall, within the limits "of the burgh for the purposes of this Act, possess such and the like rights, powers, "authorities, and jurisdiction as are possessed by the magistrates and council of "royal and parliamentary burghs in Scotland."

We are advised that in virtue of this provision the powers under the Explosives Act, 1875, vested in the magistrates and council of royal and parliamentary burghs fall to be exercised in police burghs by the magistrates and commissioners of such burghs. Hitherto, in such cases, since the Act of 1889, the powers have been exercised by the county council.

We cannot conceal from ourselves that this effect is unfortunate, and is scarcely likely to be favourable (if, indeed, it be not actually prejudicial) to the effective administration of the Explosives Act.

We have never failed to direct attention to the advantages of concentration, as opposed to the distribution, of jurisdiction, and when the Scotch Local Government Act was in preparation we successfully represented the inexpediency of bestowing a power of delegation (such as unfortunately exists in the English Local Government Act of 1888) on the Scotch county councils, because of the disadvantages which our experience told us resulted from the placing of the working of the Act in the hands of many small local authorities.

Fortunately some palliative of the evil may be found in the Local Government (Scotland) Act (sec. 76), which contains a provision for acting through a joint committee of a county council.

Section 76. Appointment of joint committees.

This provision runs as follows:—"(1.) Any county councils or county councils and "town councils may from time to time join in appointing out of their respective "bodies a joint committee for any purpose of this Act, in respect of which they are "jointly interested.

"(2.) Any council taking part in the appointment of any joint committee may from "time to time delegate to the committee any power which such council might exercise "for the purpose for which the committee is appointed.

"(3.) Provided that a council shall not be entitled to delegate to a joint committee "any power of raising money by rate or loan.

"(4.) Subject to the powers of delegation, any such joint committee shall, in respect "of any matter delegated to it, have the same power in all respects as the councils "appointing it, or any of them, as the case may be."

And in some counties advantage has already been taken or is being taken of this provision, by the appointment of a joint committee of the county council and the police burghs to administer the Explosives Act, 1875.

A copy of a circular addressed to the clerks of the county councils from the office of the Secretary for Scotland on this subject will be found in Appendix S.

Returns furnished during the year.

No returns of the licenses granted for Small Firework Factories and Stores, and of Premises Registered by the various Local Authorities of the United Kingdom, have been called for during the year.

Entry into premises without warrant.

One report has been received of the entry of an officer of police without warrant under the provisions of section 73 during the year. The entry was effected by the officer of the Local Authority under the Explosives Act, on the 2nd March, and 4½ lbs. of gunpowder were seized on unregistered premises at Somerton, used as the Village Post Office. The gunpowder was kept in a loose way and was found dangerously near the mails. The occupier was prosecuted and fined eight shillings, including costs.

VII.

Accidents.

The number of accidents by fire or explosion of which this Department has had cognizance during the year was 113, causing, so far as is known, 32 deaths and injuring 104 persons.

But, as explained in former reports, the instructions issued to H.M. Inspectors of Mines in 1879 relieve them of the obligation of reporting any purely mining accidents with gunpowder, except in cases where it appears to them that the accident was of a character to call for an investigation by one of H.M. Inspectors of Explosives, or to

afford information which seemed likely to assist these officers in the discharge of their duty.*

Accordingly, mining accidents with *gunpowder*, except when causing loss of life (when they should be reported by the coroner, or in Scotland by the procurator fiscal), or when of an exceptional character, do not come under our notice.

The number of accidents shows a very considerable decrease, viz., 113 against 149, and this is largely below the average (134·3) for the last ten years. The number of deaths from accidents shows an increase of four, viz., 32 against 28, being under the decennial average (38·4). If we compare these figures with those of some former years the general improvement is very gratifying.

The number of persons injured last year was, we are glad to say, only 104, as against 126 in 1892. This also is below the average (109·7).

The following table shows the total number of accidents, and of persons killed and injured, during the past 10 years.

Year.	Number of Accidents.	Number of Persons	
		Killed.	Injured.
1893 - - -	113	32	104
1892 - - -	149	28	126
1891 - - -	144	39	130
1890 - - -	132	44	85
1889 - - -	132	39	102
1888 - - -	123	37	97
1887 - - -	130	43	105
1886 - - -	143	40	136
1885 - - -	133	31	74
1884 - - -	144	51	138
Total -	1,343	384	1,097
Average for last ten years (1884–1893).	134·3	38·4	109·7

It is satisfactory to note that nearly two-thirds of the accidents (67) occurred in the use of explosives and under miscellaneous conditions to which the controlling provisions of the Act do not apply, and that such accidents are chargeable with no less than 26 out of the 32 deaths, and injured 74 out of the 104 persons returned as injured. (Table VII.)

This leaves us with a balance of only 46 accidents, causing 6 deaths and injuring 30 persons in manufacture, storage, and transport, these being the conditions to which the Act does apply. The result shows a regrettable increase (3 to 6) in the number of persons killed compared with the previous year, while the number of persons injured is also slightly increased (27 to 30). The number of such accidents, however, shows a large reduction, viz., 71 to 46. (Table VII.)

Of the 46 accidents in manufacture, keeping, and conveyance, no less than 27 were unattended with personal injury, while of the 67 accidents in use, &c., only two came under our notice which were free from personal consequences. (Table I.)

The following tables, tabulating the accidents under the various heads, follow the arrangement which we first adopted in 1879, and appear to bring out clearly the various points, and to present all required information in a form convenient for reference and comparison.

* Annual Report for 1879, page 26.

SUMMARY OF ACCIDENTS.

TABLE I.—Showing ACCIDENTS of all sorts in 1893 grouped under the several heads of MANUFACTURE, KEEPING, CONVEYANCE, USE, and MISCELLANEOUS, but exclusive of the non-fatal, purely mining Accidents with Gunpowder, under H.M. Inspectors of Mines (*see* Text above).

SUMMARY.	Accidents causing Loss of Life and Bodily Injury.			Accidents not causing Loss of Life or Bodily Injury.	Total Number of Accidents.	REMARKS.
	No. of Accidents.	No. of Persons				
		Killed.	Injured.			
Manufacture - -	14	6	21	24	38	
Keeping - - -	4	—	6	2	6	
Conveyance - -	1	—	3	1	2	
Use and Miscellaneous* -	65	26	74	2	67	
Total - -	84	32	104	29	113	

* Under this head are included all accidents which occurred in the use of explosives, and immediately connected therewith; also accidents in thawing nitro-glycerine preparations, and others arising from miscellaneous causes not within the prohibitions of the Act. In short, this group comprises all accidents occurring under circumstances not immediately controlled by the Act; except the non-fatal, purely mining accidents with gunpowder, under the Inspectors of Mines.

TABLE II.—Showing the TOTAL NUMBER and NATURE of ACCIDENTS caused by each description of EXPLOSIVE in 1893.*

Class of Explosive.	Nature of Explosive.	Accidents causing Loss of Life and Bodily Injury.			Accidents not causing Loss of Life or Bodily Injury.	Total Number of Accidents.	REMARKS.
		No. of Accidents.	No. of Persons				
			Killed.	Injured.			
1. Gunpowder - -	Gunpowder* -	21	9	26	10	31	For the reference to the Index Nos. of the several accidents with each description of explosive, see the Tables grouping the accidents under the heads of Manufacture, Keeping, Conveyance, and Use and Miscellaneous. (Tables III., IV., V., VI.)
2. Nitrate-mixture -	—	—	—	—	—	—	
3. Nitro-compound:—							
Div. 1 - -	Ballistite - -	1	1	—	—	1	
	Carbonite - -	2	—	2	—	2	
	Dynamite and Nitro-Glycerine.	9	5	9	2	11	
	Blasting Gelatine -	5	2	4	—	5	
	Gelatine Dynamite	10	6	9	—	10	
	Experimental -	—	—	—	1	1	
Div. 2 - - -	Ammonite -	1	—	1	—	1	
	Gun-cotton - -	3	—	4	—	3	
	Nitro-cotton -	1	—	2	—	1	
	Roburite - -	1	—	1	—	1	
	Smokeless Powder	2	2	1	—	2	
	Tonite or Cotton Powder.	1	1	3	—	1	
4. Chlorate-mixture -	—	—	—	—	—	—	
5. Fulminate - -	—	—	—	—	—	—	
6. Ammunition:—							
Div. 1 - -	Cartridge† - -	1	—	2	—	1	† For long range wild fowl gun.
	Percussion cap composition.	1	2	3	—	1	
	Fog signals -	—	—	—	4	4	
	Small-arm cartridges.	3	—	3	1	4	
	Tube safety fuze -	—	—	—	1	1	
Div. 3 - - -	Detonators -	11	—	13	3	14	
	Priming for fuzes -	—	—	—	1	1	
7. Firework - -	Firework -	8	3	15	2	10	
	Toy caps or amorces	—	—	—	3	3	
Unknown, Unlicensed, or Doubtful.	—	3	1	6	1	4	
	Total -	84	32	104	29	113	

* Exclusive of the non-fatal purely mining accidents with gunpowder under H.M.'s Inspectors of Mines.

TABLE III.—Showing the TOTAL NUMBER and NATURE of ACCIDENTS in MANUFACTURE with each description of EXPLOSIVE in 1893.

Manufacture.

Class of Explosive.	Nature of Explosive.	Accidents causing Loss of Life and Bodily Injury.			Accidents not causing Loss of Life or Bodily Injury.	Total Number of Accidents in Manufacture.	Index Nos. in List of Explosions. (See Appendix W.)	REMARKS.
		No. of Accidents.	No. of Persons					
			Killed.	Injured.				
1. Gunpowder -	Gunpowder -	2	—	4	8	10	4,* 14,* 20,* 31,* 44, 56, 57,* 58,* 74,* 88.*	* Incorporating mills.
2. Nitrate-mixture	—	—	—	—	—	—	—	
3. Nitro-compound	Dynamite and Nitro-Glycerine.	1	—	1	2	3	32, 52,‡ 69.	‡ Fire.
	Gun-cotton - -	3	—	4	—	3	59, 61, 70.	
	Smokeless Powder	2	2	1	—	2	42, 72.	
4. Chlorate-mixture	—	—	—	—	—	—	—	
5. Fulminate -	—	—	—	—	—	—	—	
6. Ammunition								
Div. 1 - -	Percussion cap composition.	1	2	3	—	1	105.	
	Fog signals -	—	—	—	4	4	77, 84, 101, 104.	
	Small-arm cartridges.	1	—	1	1	2	43, 48.‡	‡ Fire.
	Tube safety fuze -	—	—	—	1	1	60.	
Div. 2 - -	Priming Composition No. 1.	—	—	—	1	1	40.	
Div. 3 - -	Detonators -	—	—	—	3	3	7, 24, 41.	
7. Firework -	Firework - -	4	2	7	1	5	16, 46, 63, 78, 83.	
	Toy caps or amorces	—	—	—	3	3	30, 34, 47.	
	Total -	14	6	21	24	38		

TABLE IV.—Showing the TOTAL NUMBER and NATURE of ACCIDENTS in the KEEPING of the different descriptions of EXPLOSIVES in 1893.

Keeping.

Class of Explosive.	Nature of Explosive.	Accidents causing Loss of Life and Bodily Injury.			Accidents not causing Loss of Life or Bodily Injury.	Total Number of Accidents in Keeping.	Index Nos. in List of Explosions. (See Appendix W.)	REMARKS.
		No. of Accidents.	No. of Persons					
			Killed.	Injured.				
1. Gunpowder -	Gunpowder -	1	—	2	1	2	6, 18.	
2. Nitrate-mixture -	—	—	—	—	—	—	—	
3. Nitro-compound	Nitro-cotton -	1	—	2	—	1	45.	
4. Chlorate-mixture	—	—	—	—	—	—	—	
5. Fulminate -	—	—	—	—	—	—	—	
6. Ammunition -	—	2	—	2	—	2	75, 82.	
7. Firework -	—	—	—	—	1	1	98.	
	Total -	4	—	6	2	6		

TABLE V.—Showing the TOTAL NUMBER and NATURE of ACCIDENTS in CONVEYANCE of the different descriptions of EXPLOSIVES in 1893.

Conveyance.

Class of Explosive.	Nature of Explosive.	Accidents causing Loss of Life and Bodily Injury.			Accidents not causing Loss of Life or Bodily Injury.	Total No. of Accidents in Use and from Miscellaneous Causes.	Index Nos. in List of Explosions. (See Appendix W.)	REMARKS.
		No. of Accidents.	No. of Persons					
			Killed.	Injured.				
1. Gunpowder -	Gunpowder -	—	—	—	1	1	94.	("Loch Sloy").
7. Firework -	Firework -	1	—	3	—	1	87.	
	Total -	1	—	3	1	2		

TABLE VI.—Showing the TOTAL NUMBER and NATURE of ACCIDENTS occurring in the USE of the different EXPLOSIVES, and under MISCELLANEOUS CIRCUMSTANCES in 1893.*

Use and Miscellaneous.

Class of Explosive.	Nature of Explosive.	Accidents causing Loss of Life and Bodily Injury.			Accidents not causing Loss of Life or Bodily Injury.	Total No. of Accidents in Use and from Miscellaneous Causes.	Index Nos. in List of Explosions. (See Appendix W.)	REMARKS.
		No. of Accidents.	No. of Persons					
			Killed.	Injured.				
1. Gunpowder -	Gunpowder -	18	9	20	—	18	5, 15, 19, 22, 25, 37, 38, 50, 53, 55, 64, 68, 80, 85, 92, 106, 108, 111.	
2. Nitrate-mixture	—	—	—	—	—	—	—	
3. Nitro-compound:								
Div. 1 -	Ballistite -	1	1	—	—	1	100.	
	Dynamite	8	5	8	—	8	1, 11, 28, 33, 39, 49, 102, 113.	
	Blasting Gelatine	5	2	4	—	5	2, 12, 21, 51, 96.	
	Gelatine Dynamite	9	5	9	—	9	9, 23, 26, 36, 76, 93, 97, 99, 110.	
	Gelignite -	1	1	—	—	1	62.	
	Carbonite -	2	—	2	—	2	109, 112.	
	Experimental -	—	—	—	1	1	95.	
Div. -	Tonite - -	1	1	3	—	1	3.	
	Roburite -	1	—	1	—	1	89.	
	Ammonite -	1	—	1	—	1	54.	
4. Chlorate-mixture.	—	—	—	—	—	—	—	
5. Fulminate -	—	—	—	—	—	—	—	
6. Ammunition:—								
Div. 1 -	Cartridge -	1	—	2	—	1	91.*	* For long range wild fowl gun.
Div. 2 -	—	—	—	—	—	—	—	
Div. 3 -	Detonators -	11	—	13	—	11	10, 13, 17, 27, 65, 66, 71, 79, 86, 90, 107.	
7. Firework -	Firework -	3	1	5	—	3	73,† 81, 103.†	† Socket sound signals.
Unknown or Unlicensed.	—	3	1	6	1	4	8, 29,‡ 35, 67.	‡ Hengst's powder.
	Total -	65	26	74	2	67		

* Under this head are included all accidents which occurred in the use of explosives and immediately connected therewith; also accidents in thawing dynamite, and others arising from miscellaneous causes not within the prohibitions of the Act. In short, this group comprises all accidents occurring under circumstances not immediately controlled by the Act; except the non-fatal purely mining accidents with gunpowder, under H.M.'s Inspectors of Mines.

TABLE VII.—ACCIDENTS arranged in GROUPS, according to whether they fall within or without the controlling provisions of the Act; with the results in former years, for the purposes of comparison.

—	Year.	Accidents causing Loss of Life and Bodily Injury.			Accidents not causing Loss of Life or Bodily Injury.	Total No. of Accidents.
		No. of Accidents.	Killed.	Injured.		
A. Accidents in Manufacture, Keeping, and Conveyance; being those which occur under conditions to which the controlling provisions of the Act are intended to apply -	**1893**	**19**	**6**	**30**	**27**	**46**
	1892	*23*	*3*	*27*	*48*	*71*
	1891	*25*	*5*	*29*	*37*	*62*
	1890	*17*	*8*	*17*	*50*	*67*
	1889	*17*	*8*	*16*	*40*	*57*
	1888	*19*	*6*	*24*	*35*	*54*
	1887	*22*	*12*	*22*	*45*	*67*
	1886	*20*	*2*	*22*	*58*	*78*
	1885	*21*	*7*	*18*	*64*	*85*
	1884	*23*	*15*	*25*	*46*	*69*
	1883	*24*	*8*	*30*	*84*	*108*
	1882	*18*	*13*	*22*	*59*	*77*
	1881	*20*	*12*	*19*	*52*	*72*
	1880	*20*	*3*	*22*	*37*	*57*
	1879	*16*	*7*	*22*	*14*	*30*
	1878	*20*	*11*	*23*	*27*	*47*
B. Accidents in Use and under Miscellaneous circumstances; being those which occur under conditions to which the controlling provisions of the Act are *not* intended to apply -	**1893**	**65**	**26**	**74**	**2**	**67**
	1892	*76*	*25*	*99*	*2*	*78*
	1891	*80*	*34*	*101*	*2*	*82*
	1890	*65*	*36*	*68*	—	*65*
	1889	*73*	*31*	*86*	*2*	*75*
	1888	*68*	*31*	*73*	*1*	*69*
	1887	*58*	*31*	*83*	*5*	*63*
	1886	*64*	*38*	*114*	*1*	*65*
	1885	*47*	*24*	*56*	*1*	*48*
	1884	*74*	*36*	*113*	*1*	*75*
	1883	*62*	*31*	*79*	*2*	*64*
	1882	*68*	*38*	*76*	*1*	*69*
	1881	*50*	*27*	*63*	*1*	*51*
	1880	*51*	*29*	*45*	*1*	*52*
	1879	*47*	*13*	*61*	*4*	*51*
	1878	*56*	*29*	*69*	*1*	*57*

TABLE VIII.—Showing the ACCIDENTS in MANUFACTURE, KEEPING, CONVEYANCE, USE, AND MISCELLANEOUS respectively, in each of the last Ten Years.

—	Manufacture.			Keeping.			Conveyance.			Use and Miscellaneous.			Total.		
	No. of Accidents.	No. of Persons killed.	No. of Persons injured.	No. of Accidents.	No. of Persons killed.	No. of Persons injured.	No. of Accidents.	No. of Persons killed.	No. of Persons injured.	No. of Accidents.	No. of Persons killed.	No. of Persons injured.	No. of Accidents.	No. of Persons killed.	No. of Persons injured.
1893 - -	**38**	**6**	**21**	**6**	—	**6**	**2**	—	**3**	**67**	**26**	**74**	**113**	**32**	**104**
1892 - -	67	2	24	3	1	3	1	—	—	78	25	99	149	28	126
1891 - -	55	1	23	5	3	6	2	1	—	82	34	101	144	39	130
1890 - -	64	8	15	3	—	2	—	—	—	65	36	68	132	44	85
1889 - -	52	7	13	5	1	3	—	—	—	75	31	86	132	39	102
1888 - -	50	6	16	3	—	8	1	—	—	69	31	73	123	37	97
1887 - -	63	8	18	3	4	4	1	—	—	63	31	83	130	43	105
1886 - -	73	1	18	5	1	4	—	—	—	65	38	114	143	40	136
1885 - -	80	5	15	4	2	3	1	—	—	48	24	56	133	31	74
1884 - -	67	15	25	2	—	—	—	—	—	75	36	113	144	51	138
Total -	609	59	188	39	12	39	8	1	3	687	312	867	1,343	384	1,097
Average for last 10 years.	60·9	5·9	18·8	3·9	1·2	3·9	0·8	0·1	0·5	68·7	31·2	86·7	134·3	38·4	109·7

Inquests.

During the past year we attended five inquests on persons killed by explosion; but in a considerable number of cases we have been in correspondence with coroners on the subject, and have afforded them such explanation and assistance as seemed likely to be useful.

Of Inquiries under section 66 we have held five, as follows :— Inquiries.

Consecutive No. of Report.	Nature of Accident.	Date of Report.
CIII.	Explosion at Messrs. C. T. Brock & Co.'s Firework Factory, South Norwood, on 13th March 1893. (Explosion, No. 16, 1893.) (Colonel Majendie, C.B.)	24th April 1893.
CIV.	Explosion of Drying-House at Smokeless Powder Factory, Barwick, on 26th May 1893. (Explosion, No. 42, 1893.) (Colonel Majendie, C.B.)	20th June 1893.
CV.	Explosion at Messrs. C. T. Brock & Co.'s Firework Factory, South Norwood, on 19th August 1893. (Explosion, No. 63, 1893.) (Captain Thomson, R.A.)	9th September 1893.
CVI.	Explosion of Dynamite at Sutton Harbour, Plymouth, on 13th December 1893. (Explosion, No. 102, 1893.) (Captain Thomson, R.A.)	18th December 1893.
CVII.	Explosion of Cap Composition at Messrs. Joyce's Ammunition Factory, Waltham Abbey, on 22nd December 1893. (Explosion, No. 105, 1893.) (Colonel Majendie, C.B.)	30th December 1893.

The foregoing is exclusive of a Confidential Report rendered by Colonel Ford on the circumstances attending an explosion at the Four Courts, Dublin, on the 6th May 1893.

The total number of such Inquiries since the Act came into operation is 106,* the results of which are embodied in reports which are presented to Parliament, and communicated to a number of the leading newspapers and persons immediately interested. For list of all such reports from the coming into operation of the Act, until the present time, *see* Appendix Q.

Accidents in Factories.†

Accidents factories for explosives. (Tables III.-VIII.)

Dealing first with the accidents in factories, the record, so far as the number of accidents goes, is much more favourable than in the preceding year, being only 38 (as against 67 in 1892). The total is far below the average (60·9) for the last 10 years (1884 to 1893). The number of deaths, however, is, we regret to say, in excess of the number in 1892, being 6 as against 2 only, and thus slightly above the average (5·9) for the past 10 years. The number of persons injured, 21, is slightly less than in the preceding year, 24, and is only very slightly above the decennial average (18·8). These results are, of course, to be deplored, but where the annual loss is so small, the record is likely to be sensibly disturbed from time to time by one or two exceptional accidents.‡ It is indeed rather with the averages than with the results of particular years that we are most concerned, and this average, standing as it does in the case of deaths at 6·0 only for the past 10 years, compares, we need hardly remark, most satisfactorily with the average which ruled during the seven years immediately preceding the Act coming into operation, when, as we have shown in our 1885 Report, an average of no less than 39·5 deaths occurred annually in manufacture, even on very imperfect returns. The very appreciable saving of life, during the time the Act has been in operation, which these figures represent, furnishes a striking testimony to the beneficial operation of the Act, which would undoubtedly become more striking still if the comparison could be extended to the number of persons injured.

But a further and very important observation suggests itself in connexion with this record. Satisfactory as would be the very appreciable saving of life which such figures as the foregoing indicate, even if the number of factories and the number of

* The number of Reports, however, is two in excess of the number of Inquiries, because two of them (Nos. IVA. and XVI.) relate to what were not strictly or formally Inquiries under section 66. And the fact of one of these Reports being numbered IVA. makes the total number of Reports one in excess of the highest consecutive number of such Reports. This is exclusive of several Confidential Reports.

† This does not include accidents in the manufacture of Small Arm cartridges in rooms connected with magazines, stores, or registered premises, or in the preparation or adaptation of explosives in workshops connected with magazines or stores, or the illegal making of explosives in unauthorised places.

‡ For example, a single such accident as that which occurred at the Government Gunpowder Factory at Waltham Abbey on the 13th December 1893, furnishes in its nine deaths a record more fatal than the whole of our accidents for any given year during the past decade.

persons employed therein had remained stationary, they become still more striking and still more satisfactory when it is borne in mind that this average is struck on a vastly extended trade.

Since the Act came into operation, 18 years ago, the number of factories has increased from 55 to 127, and there is a vast augmentation of the number of persons employed therein. What exactly that augmentation has amounted to we are unable to say, as no returns are available of the number of persons employed at the time of the Act coming into operation. But we do know that it has been very large, for, as our reports have shown, there has been a continuous expansion of the trade, and even during the period which elapsed between 1885 and the end of 1890 (when our last returns from the trade were obtained) while the number of factories had increased 14 per cent., viz., from 108 to 123, the number of persons employed in these factories had increased by no less than 31 per cent., viz., from 7,484 to 9,820, the number at which, (excluding about 200 more persons in small firework factories and toy firework factories,) it stood at the date of the last annual report dealing with this subject.* Moreover, a large proportion of the new factories deal with entirely new classes of explosives, and therefore with new forms of risk, and, when this is considered, the beneficial results of the Act in respect of the saving of life in manufacture becomes still more notable.

It is really not necessary to go into nice comparisons or to resort to any very elaborate manipulation of the figures to justify the satisfaction with which these results —taken in their broadest and most significant form—may be regarded. For, after all, nothing can be much more striking in its way than the fact that only six deaths in accidents by fire or explosion have occurred among over 10,000 persons† engaged in the manufacture of explosives.

Accidents in the manufacture of gunpowder. (Table III.)

The accidents in the manufacture of gunpowder amount to 8 less than in 1892, viz., 10 against 18 (or little more than half) and are, of course, much below the average (18·2) for the last 10 years. It is also with great satisfaction that we are again able to record an entire absence of fatal results from accidents in the manufacture of gunpowder, while the number of persons injured was 4 only.‡ The average of deaths per annum in the manufacture of gunpowder for the past 10 years stands now at only 2·7, while the average number of persons annually injured in the same trade is 2·2.

The following table gives the losses in gunpowder factories since 1884 inclusive :—

Year.	No. of Accidents.	No. of Persons	
		Killed.	Injured.
1893	10	—	4
1892	18	—	1
1891	14	1	4
1890	16	8	2
1889	18	1	1
1888	19	3	5
1887	16	5	1
1886	20	—	2
1885	23	4	—
1884	28	5	2
Total	182	27	22
Average for last ten years.	18·2	2·7	2·2

* *See* Annual Report for 1890, page 7. Strictly, of course, the figures should be calculated with reference to the "small" and "toy" firework factories, for *accidents* in those places are included. But as the former of these two classes of factories are licensed by the local authorities, our information with regard to them is not sufficiently precise to warrant our including them. But, so far as our information goes, the number of persons employed in this class of factory does not greatly exceed 200.

† That is to say, 9,820 persons in the regular factories, *plus* 206 persons *known* to be employed in "small" and "toy" firework factories = *10,026* total. These were the figures at the end of 1890; and as new factories have been added in 1891, and the trade has, at any rate in some directions, continued brisk, it is probable that fresh returns would show a slight increase.

‡ The formidable explosion at Waltham Abbey Gunpowder Factory, which caused nine deaths, having occurred in a Government Gunpowder Factory does not fall within the scope of the Explosives Act. (*See* section 97.)

With the exception of a fire (44) in a charcoal store through the spontaneous ignition of the material, and a fire (56) from a similar cause of some lampblack, the whole of the accidents in gunpowder factories during 1893 occurred in incorporating mills.

Spontaneous ignition of charcoal and lampblack (Nos. 44,56.

Of these accidents seven may be described as ordinary mill explosions, only one of which was attended with personal injury. In this case (14) the explosion unfortunately took place at the moment when two workmen were approaching the mill, and had arrived within range of the flash. They were both somewhat burnt. Continuing the figures given in former Reports* we have a total of 285 ordinary, incorporating mill accidents which have come under our notice during the 18 years the Act has been in operation (or an average of a little under 15 a year) causing, happily, only one death and injuring 15 persons.

Incorporating m accidents (Nos. 4, 14, 20, 31, 57, 58, 74, 88).

The other mill accident (20) was due to a cause which has, unfortunately, been more fruitful of serious consequences, viz.: the striking of some indurated powder with a metal tool; more than one fatal accident has arisen from this cause, and special regulations, which have been attended with excellent results, have, at our suggestion, been adopted in the various factories to prohibit such a practice. But from time to time the regulations are transgressed; or, as in the present case, there is a more or less accidental and unsuspected contact between a metal tool and the powder. The accident (20) now under notice, occurred at a factory at Fernilee, near Buxton, occupied by the Chilworth Gunpowder Company, and was due to the engineer incautiously sounding a portion of the machinery (after the mill had been prepared for the laying of a new charge, but while the "clinker" was still on the bed) with a brass hammer. The mill-man was passing the door of the mill at the moment with three worked charges; although these fortunately escaped ignition—an example of the value of covered vehicles—the man himself was burnt by the flash.

With one exception the accidents (eight in number only) which have occurred in the manufacture of nitro-compounds have been of an insignificant character, and scarcely call for more detailed observation than will be found against the accidents respectively in Appendix W.

Accidents in the manufacture of nitro-compounds (Nos. 32, 42, 52, 59, 61, 69, 70, 72).

The one exception was an accident (42) which occurred on the 26th May, in the drying-room of the Smokeless Powder Factory, at Barwick, in Hertfordshire, by which two men lost their lives. This accident formed the subject of an Inquiry and Special Report (No. CIV.), and was conclusively shown to have been due to a spark from the chimney of a boiler-house being carried by the wind into an open window, which had been incautiously, and without our knowledge, constructed in one end of the exploded house.† As was remarked in the Special Report, this is not the first accident due to a similar cause, of which we have had cognizance, and we cited, specially, the destruction of the stove of Messrs. John Hall and Sons' Gunpowder Factory near Inveraray, on the 29th September, 1883,‡ and the destruction, at Messrs. Dickson and Co.'s Blackbeck Gunpowder Factory, on the 16th April, 1891, by means of a fire and explosion established by sparks from a neighbouring chimney.§

Explosion and fire in drying stove of smokeless powder factory (No. 42).

The dangerous proximity of the boiler-house to the stove has, since the accident, been rectified, and all openings, whether in the form of windows or ventilators, in danger buildings have been protected.

The accident (32) which occurred in a nitrating vessel at Ardeer, though in itself insignificant, and attended with no circumstances of great moment, is interesting as an example of the risks which beset the manfacture of nitro-glycerine, even in a factory where, like that at Ardeer, scrupulous attention is paid to the elimination of known risks, and where the staff have the advantage of long and valuable experience. The particular cause of this explosion is instructive, and, as far as we know, novel.

Accident in a nitro-glycerine nitrating vessel (No. 32).

The next group of explosives, in the manufacture of which accidents have occurred, is the large and varied group ranked as "Ammunition."

Accidents in the manufacture of ammunition (Table III.)

Of accidents in the manufacture of this class of explosives, only 12 came under our notice, causing together two deaths and injuring four persons. These figures, except in regard to the two fatalities, compare extremely favourably with former years. For example: in 1892 there were exactly double the number of accidents that we have now

* *See* Annual Report for 1892, p. 31.

† We were able to satisfy the jury that the accident was caused in this way, and they returned a verdict to that effect.

‡ Special Report, No. LVI.

§ Annual Report, 1891, p. 113.

to record; and, although none of them were fatal, eight persons sustained injury. The comparison is still more favourable when we note the fact, that the same accident (105) which caused the two deaths also injured three out of the four persons returned as injured.

Accident in mixing cap composition (No. 105).

This accident (105) took place at Messrs. Joyce & Co.'s Ammunition Works on the 22nd December, and was in some respects of a remarkable character. It was a double explosion, and it was the second explosion which injured (in one case fatally) the persons who were rushing to rescue or assist the man who had been hurt (as it proved fatally) by the first explosion. The circumstances are detailed at considerable length in a Special Report, No. CVII., from which it will be seen that the originating accident took place during the process of mixing a highly sensitive cap composition and that the second explosion, about half a minute afterwards, was caused by about one pound of mixed composition, which the mixer had incautiously, and contrary to instructions, left on the floor of the shed. Unfortunately, as is pointed out in the Special Report, the Company had neglected to adopt a system of mixing which we have frequently pressed upon their notice, the system, namely, in use at the Royal Laboratory, Woolwich, and at some other places, and which, so far as our experience of accidents with the same goes, is very effective in accomplishing the main object of the arrangement, viz., the protection of the workperson from injury should an accident unfortunately occur. This was illustrated by the only two accidents known to us to have occurred with this machine, viz., an accident (79/1891) which occurred at Messrs. Kynoch and Company's Factory at Witton in 1891,* and one which occurred at the Royal Laboratory, Woolwich, on the 5th July, 1892, and which is fully described in our Annual Report for that year.†

The apparatus is described in general terms in our last year's report, and in the Special Report on the accident now under notice, drawings of the machine are given; and it is our intention to exercise such power as the Act gives us to require the adoption of this (or some equally efficient protective system of mixing) in all factories where highly sensitive detonating compositions have to be prepared.

Accident in mixing priming composition for Abel's electric fuze (No. 40).

A curious example of an accident (40) due to an unusual and unexpected cause, and which also illustrates the extreme sensitiveness of some of the compositions in use, is afforded by what happened at the West Quarter Fuze and Detonator Factory on the 11th May, when about 5 ozs. of "priming composition, No. 1" for Abel's Electric Fuzes, and consisting of sulphide of copper, phosphide of copper, and chlorate of potash, was exploded through friction on a hardened drop of dried shellac varnish which had fallen on to the table.

Accident in manufacture of safety cartridges (No. 43).

The only other instance of personal injury in the manufacture of ammunition was a trifling accident (43) which occurred at Messrs. Kynoch's Witton Factory, while a woman was engaged in choking a rim fire safety cartridge, causing slight hurt to the woman.

Accidents in manufacture of fog signals (Nos. 77, 84, 101, 104).

Only four accidents are reported to have occurred in the manufacture of fog signals during the process of pressing; and, as none of these caused personal injury, they furnish further and satisfactory evidence of the protective value of the screens of which we have succeeded in procuring the adoption in the large majority of fog signal factories.

Accident at a safety fuze factory (No. 60).

A fire (60) which occurred at a safety fuze factory in Cornwall, by which the greater part of the factory was destroyed, furnished some interesting results of a negative character. The description of fuze manufactured in this factory is not the ordinary safety fuze, but what is known as tube safety fuze, as defined in the license, as "consisting of a pipe or tube of pewter, coated externally with tarred yarns, tapes, "or other suitable covering, and containing gunpowder, in the proportion of not more "than one and a half ($1\frac{1}{2}$) ounces to every twenty-four (24) feet of fuze." Of this fuze about 2,000 coils (of 24 feet each) which had not yet arrived at the stage of being coated with yarns, &c. were consumed, and about 4,000 coils of the same fuze in a more advanced stage of manufacture, or in all about 144,000 feet, or a little short of 28 miles of fuze, were consumed without any explosion whatever, which is an interesting testimony to the correctness of the classification of this fuze as "safety." The only explosion was that of about 5 lbs. of gunpowder in a small expense magazine adjoining one of the working buildings. The factory magazine, where the bulk of the powder was kept and a building used for filling the metal tubes, being isolated from the rest of the factory, escaped.

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* *See* Annual Report for 1891, pp. 32, 120.

† *See* Annual Report for 1892, pp. 41, 42.

We are pleased to be again able to record a further and sensible reduction in the number of accidents in the manufacture of detonators. During the past year only three such accidents have been reported to us, as against 11 in 1892; and in no instance was anyone personally injured. This result (especially when contrasted with what occurred in former years)* is extremely satisfactory, and testifies to the achievements of greater perfection alike in the processes of manufacture and in the protection afforded to the workpeople.

Accidents in the manufacture of detonators (Nos. 7, 24, 41).

Exclusive of accidents with amorces, of which there have been three of a trivial, and so far as personal injury is concerned, harmless character (*see* Appendix W.), there have been five accidents in the manufacture of fireworks, and two of these (16, 63) we regret to say were attended each with the loss of a life. Both these accidents occurred at Messrs. C. T. Brock and Company's Firework Factory at South Norwood; and each of them formed the subject of an Inquiry and Special Report.†

Accidents in the manufacture of fireworks; (Nos. 16, 46, 63, 78, 83), and amorces (Nos. 30, 34, 47).

The first accident (16), which occurred during the manufacture of some "drain testers" (a *quasi* firework), was conclusively shown to have been due to the unfortunate use by inadvertence of some chlorate of potash in lieu of saltpetre (nitrate of potash), under which latter designation it had improperly been sent to Messrs. Brock.

Explosion from accidental substitution of chlorate of potash for nitrate of potash (No. 16).

The other fatal accident (63) took place in a drying shed, immediately after the spell of exceptionally hot weather which occurred during the early part of August, and is believed to have been the result of the spontaneous ignition of some coloured stars, containing chlorate of potash and sulphur which had been present in the building, some of them during the intense heat of an abnormally hot period.

Spontaneous ignition of coloured stars (No. 63).

In consequence of this accident, coming as it did after many accidents from spontaneous ignition of coloured fires, and despite reiterated warnings by Dr. Dupré against the employment of chlorate of potash and sulphur in combination,‡ we felt that the time had come when some decided steps should be taken to prohibit, so far as may be, the use of such dangerous combinations, and we accordingly issued to the leading firework makers a circular in which we invited an expression of opinion as to the practicability of wholly dispensing with an admixture of chlorate of potash and sulphur in firework compositions. (For Circular, *see* Appendix V.). This circular was sent to 42 manufacturers of fireworks, of whom 21 have furnished us with replies, and the broad result is that ten state that they do not use such mixtures, and are in favour of prohibition, four state that they will support prohibition, but that they have not been altogether successful in doing away with sulphur; two more state that they find it necessary to use sulphur in roman candle stars only; whilst five are opposed to prohibition. Out of the seven who are not prepared to support prohibition, five intimate that they would do so if they could arrive at formulæ which would produce the same effect as sulphur-chlorate mixtures.

That the risk is not an imaginary one is clear from the following list of accidents which have come under our notice, which may be more or less confidently attributed to the use of chlorate-sulphur mixtures.

Date.	Reference.	Killed.	Injured.	Remarks.
26.6.76	No. 21	—	—	—
12.9.76	No. 36	4	Several	*See* Report IVA.
12.10.76	No. 42	—	—	—
5.11.76	No. 51	—	—	—
28.5.79	No. 152	—	1	—
10.5.80	No. 57	—	—	—
27.8.80	No. 74	—	—	—
6 3.82	No. 17	2	2	*See* Report XXXIX.
19.11.83	No. 162	—	—	—
21.11.83	No. 163	—	—	—
23.6.84	No. 64	—	1	*See* Report LXIII.
30.10.84	No. 116	1	1	*See* Report LXVII
15.11.84	No. 128	—	2	—
19.7.86	No. 78	—	1	—
31.10.86	No. 113	—	—	—
3.2.87$_4$	No. 10	—	—	—
11.6.87	No. 49	2	2	*See* Report LXXX.

* In 1883 no less than 45 of such accidents occurred, while from 20 to 30 was a not uncommon annual total.

† Special Reports, No. CIII. and No. CV.

‡ For quotations from Dr. Dupré's Reports, *see* Special Report CV., pages 5 and 6. *See also* Special Reports LXXX. and XCIV. on the general question of spontaneous iguition of coloured fires.

Date.	Reference.	Killed.	Injured.	Remarks.
15.6.87	No. 52	—	1	—
21.6.87	No. 56	1	4	—
27.6.87	No. 62	—	—	—
10.8.87	No. 81	—	—	—
23.8.87	No. 86	—	1	—
7.9.87	No. 90	—	—	—
5.4.88	No. 31	—	1	—
3.8.88	No. 75	—	—	—
31.7.89	No. 71	—	—	—
6.7.93	No. 87	—	3	—
9.8.93	No. 63	1	—	*See* Report CV.

The great majority of the above accidents were due to spontaneous combustion, and the remainder to the sensitiveness of the sulphur-chlorate mixtures to friction and percussion.

The large number of explosions in the summer of 1887 may probably be attributed to the excessive and prolonged heat of that year.

Having regard to this accumulated evidence, to Dr. Dupré's reiterated warnings, and fortified by the consensus of opinion of the majority (including most of the leading members) of the trade, we have felt warranted in submitting a proposal to the Secretary of State, that advantage should be taken of the powers given by Section 43 to prohibit the manufacture, keeping, importation, conveyance, and sale of any firework containing an admixture of sulphur with chlorate of potassium or other chlorate, except with the consent of, and subject to conditions approved by, a Government Inspector; and the preparation of an order to this effect is now in progress.

Accidents in charging fireworks (Nos. 46, 78, 83).

The three remaining firework accidents (46, 78, 83) all occurred during the charging of fireworks, and in two cases (78, 83) persons sustained injury, though, happily not of a severe character. The cause of these accidents, so far as could be ascertained, was friction, which in all such operations furnishes an element of risk, more or less considerable in proportion to the sensitiveness of the composition, and to the character of the precautions adopted to exclude gritty particles or dangerous foreign matter.*

Accidents in Keeping.†

Accidents in the keeping of explosives. (Table IV.). (Nos. 6, 18, 45, 75, 82, 98).

The accidents in the keeping of explosives (Nos. 6, 18, 45, 75, 82, 98) have, so far as numbers go, been more numerous than in 1892, viz., six against three; causing an exactly corresponding increase in the number of persons injured.

Happily, however, none of these accidents proved fatal.

Accident from spilt gunpowder (No. 6).

The accident (6) which occurred at Mr. Lyttle's premises at Maghera, and by which two persons were rather severely burnt, was evidently due to the presence of some spilt powder, which became ignited, probably by friction, on the floor. This accident is in respect of its probable causes very similar to one ($\frac{26}{1892}$) which occurred in 1892, at Loanhead, and which is referred to in our Annual Report for that year.‡

Accident in keeping fireworks (No. 98).

The cause of another accident (98) was not definitely ascertained, for although suspicion seemed in the first instance to point strongly to spontaneous ignition of some of the fireworks among which the accident almost certainly originated, the absence of any coloured fires, or so far as was discoverable, of any fireworks specially liable to this source of risk, throws considerable doubt upon this explanation; and the origin of the accident must we suppose for ever remain unexplained.

Accidents in the manufacture of small arm cartridges on registered premises (Nos. 18, 75, 82).

The other three accidents (18, 75, 82) occurred in the manufacture of small arm cartridges (carried on under Section 46) in filling rooms connected with registered premises.

* *See*, as to the obligation on manufacturers of searching or sifting ingredients, Section 10 (13) and Order in Council 2 (13).

† This does not include accidents in the keeping of explosive elsewhere than in magazines, stores, and registered premises.

‡ Annual Report for 1892, pp. 34, 138.

One of these (18) was due to sheer stupidity on the part of a lad in placing some gunpowder on a stove to dry—an operation which was strictly outside the powers conferred by Section 46—and which led to proceedings being taken against the occupier for such irregularity, as well as for having a fire in the filling-room. He was convicted on both charges and fined (*see* Appendix T (*b*)).

In another case (75) there was an explosion of a cartridge during filling, in one of the well-known "Erskine" machines, due, as is believed, to a shot getting under the cap.

The explanation of the remaining accident (82) which occurred also in an "Erskine" machine was not forthcoming.

Fire on registered premises at Croydon.

In addition to the above, a fire, which there is no reasonable doubt was due to incendiarism, occurred on the 3rd December, on the registered premises of Messrs. Hammond and Hussey, wholesale ironmongers, High Street, Croydon, which caused some alarm owing to the near presence of a stock of gunpowder on the premises.

It appears, however, from the information supplied to us by the Town Clerk, that the accounts in the papers as regards the risk were considerably exaggerated.

The whole of the powder present on the premises, viz., about 140 lbs. was contained in fireproof safes, and the safes containing the bulk of the powder were situated at some little distance from the place at which the premises were set on fire. As no person was killed or bodily injured in this case, it did not rank as an "accident," within the meaning of the Act (*see* Section 63).

Accidents in Conveyance.

Accidents in the conveyance of explosives. (Table V.). (Index Nos. 87 and 94).

Only two accidents (87, 94) have occurred in the conveyance of explosive, and as one of these (87) happened in the illegal and surreptitious conveyance it is strictly hardly an accident which can be properly charged against the Act.

The circumstances of the case are sufficiently detailed in Appendix W., briefly, they are as follows: a Mr. Thompson was conveying some coloured fire which he had (illegally) prepared, and which contained unwashed flowers of sulphur and chlorate of potash.

The mixture was in a bottle in a leather bag on the middle seat of a first-class compartment of the Manchester, Sheffield, and Lincolnshire Railway, when it suddenly exploded, doing much damage to the carriage and injuring Mr. Thompson and the other two passengers present.

Although the whole case was attended with serious illegalities, the railway company consented under the circumstances, and in view of some heavy expenses and loss which Mr. Thompson sustained, and at his urgent request, to forego proceedings considering that the case had carried with it its own punishment.

The case was an extremely interesting illustration of the danger of chlorate-sulphur mixtures on which we have remarked elsewhere,* especially when, as in the present instance, the sulphur is unwashed. As stated in connexion with Accident No. 63, steps are now being taken to prohibit the use of such mixtures except with the consent of, and under conditions approved by, a Government Inspector.†

The other accident (94) in conveyance, might easily have assumed formidable proportions, but for the promptness of those who dealt with it. The circumstances are as follows:—

The "Loch Sloy."

The "Loch Sloy," a British barque bound for Adelaide, was taking in 20 tons of gunpowder at No. 1 Buoy, Tail of the Bank, Greenock, and after 10 tons had been stowed away in the magazine in the main hatch, it were found that the vessel was on fire. After some little time and trouble was expended in discovering its source, it was found to have proceeded from the woodwork at the back of the range in the galley, becoming ignited by the flame passing through a small hole in the iron protecting plate at the back of the range (within a couple of feet of the main hatch).

Fortunately the fire was extinguished in about 25 minutes, and with but little damage to the vessel. But it nevertheless revealed a new source of danger, by the failure of the sheet iron to protect the woodwork from ignition, by the flames of the cooking range fire.

It was clear that the promptness with which the fire was extinguished prevented an explosion almost similar to that which occurred at the same spot on board the "Auchmountain," in September, 1892.

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* *See* p. 33. † *See* p. 34.

In consequence of this case, which recalls, as above stated, the actual and somewhat formidable explosion of 20 tons of gunpowder on the "Auchmountain," off Greenock, on 3rd September, 1892,* and of the new source of danger which it disclosed, we felt our it duty to communicate with the Board of Trade and with all occupiers of floating magazines, suggesting that vessels designed to carry explosives, or for the storage of the same, should have the woodwork in the immediate vicinity of a galley or other fireplace protected either (*a*) with two sheets of sheet iron or steel (with, preferentially, a small air space), or (*b*) with one sheet of sheet iron and steel, with a layer of asbestos.

A copy of our circular letter of 7th December, to the occupiers of floating magazines will be found in Appendix O.

The Board of Trade have also issued instructions to their officers in the same sense; and we trust that by these means this (hitherto unsuspected) risk may be avoided.

Accidents in use.

Accidents in the use, &c. of explosives (Table VI.).

The accidents grouped under the head of Use and Miscellaneous (Table VI.), were, we are pleased to say, less numerous than in 1892, viz., 67 as against 78, but the number of deaths was almost exactly the same, viz., 26 as against 25, while the number of persons injured showed a large reduction, viz., 74 as against 99.

These figures are below the average for the past 10 years, a result which may doubtless be partly credited to the great coal strike which, necessarily, caused a very sensible diminution in the quantity of explosives used, and for several months suspended, so to express it, the possibility of blasting accidents in connexion with coal mining.

It is proper again to recall an observation of former years as to this being a class of accident in which, from the imperfect character of our information and other causes, the annual fluctuations are liable to be considerable, and also the more important remark that this is a class of accident to which the controlling provisions of the Act do not directly apply, and in respect of which we have therefore no actual responsibility. The Act does not control the use of explosives, and all we can do is to study the different accidents occurring under this head, and extract from them as much information and instruction as they may be capable of furnishing, and apply the same (by way of suggestion) for the benefit of those concerned in the use of explosives.

There have been 18 accidents in the use, &c. of gunpowder (against 24 in 1892), and these accidents caused 9 deaths and injured 20 persons. The whole of these figures are, we are glad to say, below the average, as the following table shows:—

Accidents in the use, &c. of gunpowder (Table VI.)

	No. of Gunpowder Accidents.	Deaths.	Persons Injured.
1893 - - -	18	9	20
1892 - - -	24	13	31
1891 - - -	29	15	32
1890 - - -	24	21	18
1889 - - -	27	14	38
1888 - - -	26	14	25
1887 - - -	33	18	32
1886 - - -	27	21	63
1885 - - -	24	8	32
1884 - - -	36	25	41
Total - - -	268	158	332
Average for last 10 years 1884 to 1893.	26·8	15·8	33·2

N.B.—*In some of the foregoing instances gunpowder was associated with other explosives, and in those cases the accident is generally returned as a "gunpowder" accident, though gunpowder may not in all cases have been the originating cause.*

The gunpowder accidents were generally of a very ordinary character: projected debris (15, 64); explosion due to fire or spark or red-hot cinder (5, 68, 85, 106); hang

* *See* Annual Report, 1892, p. 34; *also* Special Report, No. C.

fires (55, 111); ramming with undue force (22, 25); ramming with wooden rammer (19); boring out tamping (50); bursting of small cannon (53); children playing with gunpowder (33, 80, 92). The circumstances of each of these accidents are set forth in sufficient detail in Appendix W.

But two rather curious accidents occurred which merit a passing notice.

In one of these cases (37) a man at South Craighall, Lanarkshire, inadvertently placed a tin canister containing gunpowder, but which was believed to contain tea which it was desired to warm up, on to the fire, when naturally an explosion occurred, injuring four persons.

An almost identical accident (108) occurred later in the year at Mansfield, New Cumnock, a can containing gunpowder being placed in mistake for one containing tea by the fire in a miner's cottage. The resulting explosion proved fatal to a child and severely injured the miner.

It is remarkable that two accidents of exactly the same character, but of what may be regarded of so unusual a description should occur in the same year.

Accidents in the use of nitro-compounds (Table VI.)

Of accidents in the use, &c. of the very large and important group of explosives ranked as nitro-compounds, we have, as was to be expected, a considerable number, viz., 30, to which are due 15 deaths, and 28 cases of bodily injury.

Accidents with explosives of 1st division of nitro-compound, class 3 (Table VI.)

Dealing first with accidents due to the first division of this class, *i.e.*, to nitro-glycerine preparations, it appears that 26 of this class came under our notice, causing 14 deaths and injuring 21 persons.

On the whole this result (even making allowance on account of the prolonged coal strike, and to the probable large reduction in the quantity of explosives used),* is not unsatisfactory, especially if regard be had to the continual increase in the use of explosives of this large and important class.

The following table shows the results during the past 10 years:—

	No. of Accidents.	Deaths.	Persons Injured.
1893	26	14	21
1892	26	9	33
1891	30	12	45
1890	24	12	30
1889	32	13	33
1888	22	14	20
1887	17	10	21
1886	22	15	29
1885	14	11	10
1884	16	5	17
Total	229	115	259
Average for 10 years	22·9	11·5	25·9

The majority of these accidents were of a common enough character, in which the use of undue force or improper tools in ramming (1, 21, 63, 96, 97, 109, 110) occupies as usual a prominent place. In two of these cases (63, 113) the risk was accentuated by the use of iron tools.

Projected débris is responsible for four accidents (33, 36, 76, 99), and the same number of accidents (9, 12, 26, 51) resulted from workmen incautiously approaching hang fire "shots" or "shots" which were supposed to have gone off. The too fruitful source of accidents, unexploded portions of a charge, has this year, we are pleased to say, been responsible for only two accidents (23, 39), a result which compares favourably with the past. We may perhaps venture to believe that our efforts to make the circumstances under which such accidents are likely to occur better understood are beginning to bear fruit, and it may not be out of place here to reproduce a passage on this subject from former Reports:—

"It is too much to hope that accidents from this cause can ever be wholly got rid of; indeed, even with the best precautions, they are not easy to avoid, but much may be done by a recognition of the fact (of which many persons engaged in blasting

* It should, however, be noticed that it is not in connexion with coal mining, but rather in connexion with metalliferous mining, that the largest expenditure of this class of explosives occurred.

appear to be ignorant) that the risk from this source is of an appreciable and even formidable character. Among the precautions which might usefully be adopted to avert or diminish it would be the use of *wooden* tools for turning over or disposing of débris from any blast with high explosives when there is the slightest ground for suspecting any incompleteness in the explosion of the charge."*

It is with much satisfaction that we are able to report that only two cases of accidents (11, 93) from the improper thawing of nitro-glycerine preparations have come under our notice during the year.

This source of risk has been so prolific of accidents in the past, and it is so important to keep before the public and before those into whose hands these explosives may fall for use, the reality of the risk if any attempt be made to thaw the explosives by other than the recognized means and apparatus, that we have thought it well to bring up to date and to repeat here the list which we gave last year, of accidents of this sort.† (Appendix X.) Adding the two deaths and the two injured by this cause in 1893, the Appendix shows a total of 72 such accidents, causing 60 deaths and injuring 87 persons, a sad record when it may be fairly said that every life recorded as lost was literally "fooled away."

It is fair to remark that our efforts to diminish the number of such accidents by bringing into prominence the gravity of the risk, and the importance of providing proper thawing apparatus, have been well seconded by the manufacturers. We have in former reports quoted the instructions issued by Nobel's Explosives Company and others.‡

This year Nobel's Company have again issued a strenuous communication to their agents, from which we think it desirable to quote some extracts :—

"The Home Agents of
"Nobel's Explosives Company, Limited.

1st November, 1893.

"Gentlemen,

"IMPORTANT.

"You are aware that all the explosives of the nitro-glycerine class are liable to become hard from the action of cold, and are less sensitive to detonation whilst in that condition, but please note particularly that in some instances the congealing may not be readily discoverable by the touch, the cartridges retaining to some extent their plastic condition.

"We think it right on the approach of winter to once more draw your attention to the importance of inducing every customer in your district to provide himself with warming pans for the purpose of softening or thawing all cartidges before attempting to use them.

"Be good enough to carefully read the enclosed leaflet, of which a supply is sent you by the same post, and to send a copy to each of your customers.

* * * * *
* * * * *

"Should any accident of the nature to which we have referred unfortunately occur in your district, we expect you to be able to report to us that the proprietor of the works or mine at which it may have occurred, had been duly warned beforehand to provide his workmen with suitable warming pans.

"It is most important that Nobel detonators of sextuple strength, and none less strong, should be used for exploding the gelatinous compounds. The provision of warming pans and suitable detonators to *every* customer should absolutely prevent the recurrence of complaints that in the winter season our dynamite, blasting gelatine, gelatine dynamite, and gelignite do not so readily explode as at other seasons of the year.

"Warming pans and sextuple detonators can be forwarded promptly to any agent whose stock is insufficient to meet immediate demands.

"Yours faithfully,
"Nobel's Explosives Company, Limited,
"F. J. Shand,
"Assistant Manager."

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* Annual Report for 1892, p. 39. † Annual Report for 1892, pp. 158–160.

‡ *See* Annual Report, 1886, pp. 38, 40 ; 1890, p. 39 ; 1891, pp. 35–36 ; and Special Reports LXXII. and XCII.

GELIGNITE, GELATINE-DYNAMITE, DYNAMITE, AND BLASTING GELATINE.

NOBEL'S EXPLOSIVES CO., LIMITED, GLASGOW.

IMPORTANT NOTICE.

NOBEL'S EXPLOSIVES COMPANY, LIMITED, beg to draw their Customers' attention to the repeated warnings contained in their various Circulars and Pamphlets, in which it is clearly pointed out that cartridges of Gelatine-Dynamite, Gelignite, Dynamite, and Blasting Gelatine become congealed during COLD WEATHER even at a temperature so high as 45° F., and that this may occur without altering the soft and plastic outward appearance of the cartridges.

DIRECTIONS FOR USE OF EXPLOSIVES IN COLD WEATHER:—

ALL cartridges before blasting should be heated in Warming Pans. Specially designed Warming Pans should alone be used for this purpose, and in them the cartridges can be kept in a proper usable condition for several hours in the coldest weather.

ON NO ACCOUNT expose cartridges to the direct heat of fire, or place them on a hot stove or warm piece of metal, or on a steam pipe. Do not attempt to heat them by these or any other irregular means, or ACCIDENTS thereby will INEVITABLY OCCUR.

There should be NO FIRE, &c. in the hut or apartment in which the thawing is conducted.

ONE CARTRIDGE at a time should be GENTLY PRESSED, not forced, to the back of the bore-hole, and great care should be taken to AVOID JAMMING OR "BUNCHING."

WARMING PANS, specially constructed, are supplied by all Agents of the Company at nominal prices, as under:—

No. 1 Warming Pan to treat 2½ lbs. at a time - each.
No. 2 „ „ 5 lbs. „ - „

Extra-sized Warming Pans at proportionate prices.

THOS. JOHNSTON,
General Manager.

Glasgow, 2nd November, 1891.

For Gelatinous Explosives use Specially Strong Nobel Detonators.

NEVER USE FROZEN CARTRIDGES.

The only other accident which calls for special notice was one (102) which occurred in the course of some submarine operations which were being carried on for the deepening of Sutton Harbour, Plymouth, and by which two men lost their lives. Accident at Sutton Harbour, Plymouth (No. 102).

The accident formed the subject of an Inquiry and Special Report (No. CVI.). The circumstances of the case, however, proved sufficiently simple, as it was clear that the accident was due to the charge having remained and exploded in the iron pipe by which it was conveyed from the flat or barge into the submarine rock. The accident was almost identical with one (3) which occurred on the Manchester Ship Canal on 10th January when tonite was being used instead of dynamite. In the Special Report on the Plymouth accident (102) will be found some practical suggestions which Captain Thomson (who held the Inquiry) was able to make with a view to avoiding accidents of this kind in future.

The other accidents (2, 28, 49, 100) with this group of explosive call for no further notice than is accorded them in Appendix W. The accident (100) with ballistite occurred by the bursting of an experimental gun during testing. Accidents No. 2, 28, 49, 100.

Accidents with explosive of 2nd division of nitro-compound class (Table VI.) (Nos. 3, 54, 89).

The accidents with explosive of the Second Division of the nitro-compound class have been few and inconsiderable.

One of them (3) which occurred in some blasting operations with tonite on the Manchester Ship Canal has been already referred to in connexion with the accident 102,* and calls for no further notice.

The only roburite accident (89) was due to the application of this explosive to a purpose for which it was not intended, viz., as a charge for a small cannon during some wedding festivities.

The single explosion of ammonite (54) occurred during ramming, and was probably the result of the firing of the detonator during that operation.

Accidents with detonators (Nos. 10, 13, 17, 27, 65, 66, 71, 79, 86, 90, 107).

The accidents with detonators of which we have had cognisance have been rather less numerous this year, viz., 11 as against 16 in 1892; and by these accidents 13 persons (as against 20) sustained injury. Of these, as usual, the larger proportion, viz., seven (10, 17, 65, 66, 79, 86, 107) were caused by children playing with a stray detonator of which they had obtained possession, generally trying to pick out the composition. The injuries though locally severe did not extend beyond the children immediately concerned, and were generally limited to loss of a finger or two or other severe injury to the hand.

Two cases (13, 27) occurred of the explosion of a detonator while being fitted to a fuze; in another case (71) the explosion was produced by a miner lighting a fuze with a detonator attached and throwing it on to the floor of the tap room of a public-house; the remaining case (90) was probably the result of ignorance on the part of a labourer who had stolen some detonators, fuze, &c. from a dealer's premises.

Accidents with cartridge for wild fowl shooting (No. 91).

The only case of accident in connexion with the use of cartridges which has come under our notice was one which occurred at Dover, through two boys hammering a cartridge which they had found, and causing it to explode with injury to both the lads. The cartridge proved to have been one for a long range wild fowl gun, and its charge was about $1\frac{1}{4}$ oz. of powder, but fortunately being unshotted, the results were far less serious than they might otherwise have been.

Accidents with fireworks (Nos. 73, 81, 103).

We are pleased to be able to state that the accidents in the use, &c. of fireworks have been extremely few, viz., three only, causing one death and injuring four persons.

One of these (81) occurred at the Theatre Royal, Eastbourne, during the representation by Mr. D'Oyley Carte's Company of "Haddon Hall." It is usual in theatres to produce lightning effects by means of a flash caused by dropping a small pinch of a composition consisting of magnesium (two parts) and chlorate of potash (one part) on to a heated metal plate.

Unfortunately in this case, through the incaution and disobedience of orders of one of the operators the whole batch of composition (about 10 ozs.) became ignited and an explosion of some violence ensued, which broke the leg of one of the men, injured another man, and inflicted cuts upon a member of the audience by broken glass.

It may be advisable that we should here quote a letter which we addressed to Mr. D'Oyley Carte as the result of our investigation of the circumstances of the case. The matter is at present occupying the attention of the London County Council:—

"Home Office, Whitehall, S.W.
17th October, 1893.

"Sir,

"With reference to the accident which occurred with your travelling company at Eastbourne on the 21st ultimo by an explosion of some powder used in producing the lightning in the 'Storm' scene of 'Haddon Hall,' I have now, with the assistance of our chemical adviser, carefully examined the sample of the powder and ingredients which I obtained at the Savoy Theatre from your stage manager on the 11th instant, and also the portions of the apparatus which were recovered after the explosion.

"The result of this examination leaves me in no doubt that the explosion occurred outside the apparatus, and probably behind it, and this conclusion coincides with the other probabilities of the case, viz., that the explosion was due to the stock of powder, consisting, I believe, of some 10 ozs., becoming ignited probably by a spark thrown out of the apparatus when a flash was being produced. The mixture is not specially sensitive to explosion by friction or percussion. It can be so exploded, as for example, by a blow of a wooden mallet when the composition is resting upon a slab of stone, but its relative want of sensitiveness in this respect excludes all probability of it having been ignited by a fall or a blow. As I have stated, I have little doubt it was ignited by a spark from the apparatus. When ignited the mixture is extremely violent, much more so than ordinary gunpowder; and it is, therefore, not surprising that such a

* *See* p. 39.

quantity as 8 or 10 ozs. should produce local effects which are ascribed as having resulted in the present case.

"I do not think that the proper use of the apparatus is attended with risk. By the proper use, I mean the introduction of a *small* pinch of the mixture in such a way that no risk of the ignition of a larger quantity will arise, but in order to avoid such risk one or two suggestions occur :—

"(1stly.) Imperative instructions should be issued to prevent more of the mixture being taken to the apparatus than is actually required for immediate use. And I understand from your stage-manager and Mr. Kerr that under no circumstances could more than 1 oz. be required by the operator.

"(2ndly.) Although the material is not specially sensitive to explosion by friction or percussion, the use of a metal receptacle is undesirable, especially having regard to the possibilities of friction becoming established between the metal lid and the body of the receptacle. I am, therefore, of opinion that it would be well that the mixture should be kept in either a gutta-percha or glazed cardboard box, such as is commonly used for containing detonating composition in cap factories, &c. And, I think, for the purposes of immediate manipulation, *i.e.*, to contain a quantity from which the operator takes the pinches, a box of the same material should be supplied having a hinged lid with a thumb-piece which would permit of its being readily opened to take out the pinch when it would close automatically.

"(3rdly.) I observe that in the flash plate, holes exist up to the circumference of the plate, and I think it not impossible that powder might fall through these outer holes and accumulate unignited around the lamp, and such an accumulation might become formidable. I think, therefore, it perhaps would be well to have the flash plate made with holes only at such places as would *ensure any* powder that fell through being ignited.

"If you will send to the Home Office for the lamps, receptacles, and other articles which I took away from the theatre, they will be handed over to your messenger.

"It is my duty to call attention to the fact that the mixing of the ingredients to form this composition constitutes an act of manufacture of an explosive (having regard to the definition of an explosive in Section 3, and to the prohibitions of Sections 4 and 39), and accordingly cannot be carried on except in a licensed place. The matter, however, is perhaps rather one for the London County Council as Local Authority than for this Department; but it will be for your consideration whether, with a view to the better observance of the Act, the mixture could not be obtained ready prepared. It may also be worthy of your consideration whether the lightning effects which you desire to produce might not be accomplished without any conflict with the Explosives Act, and without the slightest risk from explosion, by the use of one or other of the magnesium flash lamps supplied for photographic purposes. In these lamps simply metallic magnesium is employed, which by itself is absolutely unexplosive.

"I have the honour to be,
"Sir,
"Your obedient Servant,
"(Signed) V. D. MAJENDIE,
"Colonel,
"H.M. Chief Inspector of Explosives."

Socket signals (Nos. 73, 103).

The other two accidents (73, 103) occurred with socket signals. The most important of them (103) occurred on board the S.S. "Rose," plying between Holyhead and Dublin; the signal having failed to ascend and exploding on the deck, with fatal results as regards a fireman and injury to a passenger. It is doubtful in this case whether the failure was due to the signal being blown back by a squall or to it being insufficiently rammed home, or, as is most probable, to the propelling charge having become damp.

At any rate, be the cause what it may, it justifies, in view of former accidents with this class of signals, and the other case of this sort recorded this year (73) our anxiety with respect to socket signals. They are, doubtless, valuable signals when they act correctly; but when a failure occurs from one of the various causes which may become operative, or when they fall into ignorant or careless hands, the result is liable to be disastrous. They then become shells or infernal machines of no little power. We here append a list given in former reports of accidents with this class of explosive, and which we have brought up to date by the addition of the two above

noticed, and by an accident which only recently came to our notice, although it occurred in 1884, on board the "City of Paris," and which was attributed by the Naval Court which investigated the circumstances to the signal having been damp.

The Board of Trade in their instructions to their surveyors call attention to the risk and urge the importance of periodical and not infrequent renewal of the signals to obviate this source of danger.*

Number.	Accident.	Killed.	Injured.
(1.) No 93 / 1884.	Explosion of socket distress signal at Bournemouth (*See* Annual Report, 1884, page 35, and Special Report, No. LXV.)	1	8
(2.) No number / 1884.	Explosion of socket distress signals on board "City of Paris."	1	5
(3.) No. 106 / 1885.	Ditto at Liverpool (*See* Annual Report, 1885, page 54.)	1	8
(4.) No. 142 / 1886.	Explosion of socket sound signal at Gravesend (*See* Annual Report, 1886, page 40.)	—	3
(5.) No. 54 / 1887.	Ditto at Partick (*See* Annual Report, 1887, page 41.)	1	15
(6.) No. 98 / 1888.	Explosion of socket distress signal at Birkenhead (*See* Annual Report, 1888, page 44.)	—	3
(7.) No. 31 / 1890.	Ditto on board S.S. "Dominion," Liverpool (*See* Annual Report, 1890, page 41.)	1	—
(8.) No. 106 / 1890.	Explosion of sound signal rocket in Whitechapel Road (*See* Annual Report, 1890, page 41.)	1	1
(9.) No. 81 / 1891.	Explosion of socket sound signal at Wexford (*See* Annual Report, 1891, page 38.)	3	1
(10.) No number (17th June 1891.)	Explosion of socket distress signal on board "City of Chicago." (*See* Annual Report, 1891, page 38.)	—	3
(11.) No. 25 / 1892.	Explosion of sound signal rocket at Bridlington Quay (*See* Annual Report, 1892, pages 40 and 137.)	1	4
(12.) No. 60 / 1892.	Explosion of socket sound signal at Hayle (*See* Annual Report, 1892, pages 40 and 148.)	—	2
(13.) No. 93 / 1892.	Explosion of distress socket signal on board S.S. "Princess Alexandra." (*See* Annual Report, 1892, pages 40 and 148.)	1	1
(14.) No. 122 / 1892.	Explosion of socket distress signal at Glasgow (*See* Annual Report, 1892, pages 40 and 153.)	—	—
(15.) No. 73 / 1893.	Explosion of socket sound signal at Walthamstow (*See* Annual Report, 1893, page 41.)	—	—
(16.) No. 103 / 1893.	Explosion of socket distress signal on board S.S. "Rose." (*See* Annual Report, 1893, page 41.)	1	1
	Total	12	55

Accidents in illegal manufacture.

Of accidents in the illegal manufacture of fireworks we have, happily, none to report this year.

Explosion with unknown or unauthorised explosives. (8, 29, 35, 67).

Of explosions in connexion with unknown, doubtful, or unauthorised explosives there have been four during the past year, causing one death and injuring six persons.

We are unable to come to any conclusion as to the circumstances of the fatal explosion (35) at Thirlmere, the evidence obtainable having gone no further than sufficed to establish that it had originated in an oven of a kitchen range, but what the explosive was or how it came there was not established.

* *Regulations for survey of steamships carrying passengers*, 1893. Clause 73.

Explosion in breaking up old metal. (8).

The explosion (8) at Deptford fortunately directed attention to a risk which might have been attended with most disastrous consequences and no small loss of life, for the examination which, at our instance, was instituted by an officer of the London County Council, brought to light the fact that a heap of old metal which had been purchased (by some dealers in old metal) of the Maxim Nordenfelt Guns and Ammunition Company, Limited, and which it is understood had been declared to be wholly free from explosive, included, in fact, a not inconsiderable quantity of filled or partially filled shell, and had these found their way into the furnace (as had the one which exploded) or under the breaking-up hammer, serious results might have ensued. The negligence on the part of the Maxim Nordenfelt Company appeared to be so grave and inexcusable that we felt it our duty to recommend proceedings for certain offences of which they had been guilty against the Act, and they were convicted and fined. (*See* Appendix T(*a*).)

Accident with "Hengst's powder." (29).

The only other explosion in this category was the explosion of some "Hengst's powder" (an unauthorised explosive which has not passed beyond the experimental stage in this country), due to some molten alloy with which Mr. Hengst was experimenting in an outhouse attached to his premises at Plumstead, running into and firing some of the powder which he had by him. He and his wife were both a good deal burnt, and some local alarm was created, the impression having apparently got abroad that he had large quantities of explosive on the premises, and that the risk to the neighbourhood was considerable.

Although these apprehensions were exaggerated, we thought it proper to cause a warning to be conveyed to him (through the London County Council) against continuing his experimental operations under the conditions which had hitherto prevailed.

Explosions in Government Factories or with Explosives belonging to the Government.

We regret to have to record, among the accidents in Government factories, or with explosives belonging to Government, one of a serious character which entailed an unfortunate loss of life.

Explosion in the Cam House at Waltham Abbey.

This was an explosion which occurred about 2.35 o'clock on the morning of the 13th December in one of the prism press houses, known as the "Cam House," at the Royal Gunpowder Mills, Waltham Abbey, by which one man was killed on the spot, another died shortly after, and eight others were seriously injured, seven of whom succumbed to their injuries, and only one recovered, one having escaped uninjured.

Thus, of the 11 men who were in or about the house at the time of the accident, nine were killed and one received serious injury.

This loss of life exceeds that which we have had to record in any gunpowder factory since the Act came into operation, the nearest approach to it being the loss of six lives at Roslin Gunpowder Factory in February 1890.*

The building in which the accident occurred (and which was of wood with a brick south wall) was divided into two portions, with a water-wheel between them, the wheel being separated from the compartments by wooden walls. In each end were two presses or cam machines; these consist of six moulds which are made of bronze, the grain is fed into them by a sliding table having six fillers of gunmetal, which are themselves fed from a hopper, into which the grain is poured; the table moves backwards and forwards, and besides serving to carry the charges, pushes forward the prisms after having been pressed.

There are two sets of plungers of bronze, top and bottom; through the latter, which serve as guides, pass the bronze needle or needles which form the channels in the prisms. The upper plungers have holes into which the needles pass, when they come down to give the pressure, the whole is worked by means of eccentrics, and at the time of the accident the machines were engaged in pressing "EXE" prism powder from grain (a powder intermediate between black and brown powders, or rather a combination of the two).

A boat was alongside the house unloading grain and loading prism.

The quantity of powder in the house and in the boat was about 1,200 lbs., reckoning both grain and formed prisms.

* Annual Report, 1890, p. 32; also Special Report XCI.

The *explosive* effect was very slight, the house being merely burned down, without any fracture or disturbance of the only wall (at south end) built of masonry. The water-wheel and the four cam machines were practically uninjured.

The coroner's jury returned an open verdict; they, however, expressed an opinion that the grouping of the machines in sets of four had contributed to the accident. Also that nightwork should be abolished; that steel tools should not be allowed except in the hands of experienced mechanics; and that the machines should be stopped whilst powder boats were alongside.

They requested that these points should be strongly represented to the Home Office.*

Destruction by fire of guncotton drying stove at Waltham Abbey.

An interesting example of the burning, without explosion, of a considerable quantity of guncotton, was afforded by what occurred in a guncotton stove at Waltham Abbey on the 2nd March.

The following particulars are derived from a report furnished by the War Office:—The stove was a circular building, 30 ft. 3 ins. in diameter, with conical roof, height at the eaves 10 ft., at the centre 16 ft. The walls were double and of wood, the boards being nailed to wooden uprights, the space between the inner and outer walls was about 3 inches. A wooden partition divided the interior of the stove into two equal portions. The roof was of zinc, the floor was of wood covered with lead. The whole of the interior of the stove was lined with Willesden paper secured to the sides and roof by means of wooden fillets. The stove was surrounded by a circular brick traverse, backed by earth, with a slope of about 30°. The stove was entered by a tunnel through the traverse 7 ft. 6 ins. high and 6 ft. 6 ins. broad, which was match-boarded inside. The outer end of the passage was closed by a double door, the stove end had two doors, one leading into each side of the stove. A door in the left side of the passage at the stove end gave access to the space, about 2 feet broad, between the wall of the stove and the wall of the traverse.

The stove was heated by means of a hot-air blast, produced by a combined engine and fan and lead through a steam-heater.

The hot-air pipe was carried overhead through the passage into the stove. On entering the stove, the pipe, which was of copper, covered with painted canvas, and 9 ins. in diameter, was turned down and carried round the stove about 6 ins. from the walls and 6 ins. from the floor. There were seven outlets from the pipes, on both sides of the stove, the open ends of which were covered with fine copper gauze, and arranged so that the blast impinged on to the floor. The temperature of the stove was regulated by means of valves in the pipes outside the stove, which determined the proportion of hot and cold air which was allowed to enter. The air escaped from the stove by means of six windows, about 1 foot square. The stove was lighted by external electric lights, the passage by one light inside.

The interior of the stove was fitted up with movable wooden racks, round the sides and against the partition, arranged for five tiers of trays, of which there were 200. The trays were light wooden frames, with fine copper wire-gauze bottoms; each tray held 48 moulded discs, $4\frac{1}{2}$ ins. high by 3 ins. diameter, each weighing 9 ozs. when dry, and containing when wet 42 per cent. of moisture.

The stove was charged on Friday, the 24th February 1893, at 6 p.m., with 4,212 lbs. of guncotton; there were no discs on the bottom tier of trays.

The stove was visited by the man in charge at 6.30 a.m. on the morning of the accident. He found the temperature to be 102° F. on one side and 103° F. on the other. The electric light was not on.

The men were on their way to the stove to prepare for removing the dry guncotton, when at 7.25 a.m., a bright flame was observed to shoot high up into the air with a roar, but no explosion took place. The roof disappeared entirely, some melted zinc being deposited on the crest of the traverse, and some sheets on the slope. The outer door of the passage was found locked, and had to be opened to admit the firemen with the hose. The woodwork burnt fiercely, but the flames were subdued before the outer wood wall and the uprights were consumed. The lead floor was much melted, and the copper pipes distorted and fused. Not a single brick of the traverse was displaced.

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* While this Report has been in preparation a War Office Committee has been appointed, with Lord Sandhurst as President, and Her Majesty's Chief Inspector of Explosives as one of the members, to investigate the whole subject, and we reserve, therefore, until another occasion, detailed remarks on the accident and its probable cause, and as to the precautions proper to be taken.

A fresh south-westerly breeze was blowing at the time; on the south-west side of the stove little débris was found, and that only in the immediate vicinity. On the north-east side a few light articles were carried some distance, evidently by the wind, the most distant article being that of the charred framework of a guncotton tray, which was lying 140 yards from the centre of the stove. Minute particles of what appeared to be charred paper were found as far as 640 yards distant from the stove.

The War Office authorities stated that they were unable to assign a cause for this accident.

We believe that there is no previous case on record of the destruction of so large a quantity of guncotton by fire without explosion.

The largest quantity, so far as we are aware, which has burnt inexplosively was about 1 ton of (compressed) guncotton discs of Stowmarket make stored in a magazine at Penryn, in October 1869, which caught fire and burnt harmlessly away.*

Again, on 25th July 1882, 1,500 lbs. of potentite (nitrated guncotton) burnt without explosive effect in the store of the (then) Potentite Co. at Melling.†

On the other hand, there have been a large number of experiments, and some accidents, in which very much smaller quantities of guncotton, when set on fire, have exploded with tremendous effect.

One of the most striking of the accidents, at any rate in contrast with the present case, was the destruction by explosion on 27th October 1882 of a nitro-cotton drying stove at Ardeer.

On that occasion the stove did not contain more than 308 lbs. of nitro-cotton (distributed in two compartments).

The ignition (probably by friction) of this guncotton resulted in an explosion of considerable violence, by which two men were killed, and the stove was destroyed.‡

Other instances of explosion of quantities of guncotton, considerably less than the amount which now has burnt harmlessly away, may be mentioned; one of the most striking being the explosion of about 1 ton of guncotton (contained in 896 tins) at Lydd, on 24th January 1884, with considerable injury to Sir F. Abel, who had undertaken to light the fire by which the guncotton was to be ignited.§

Then there was the explosion at Eastbourne in April 1872 of only 6 cwt. of guncotton packed in strong wooden cases.‖

Other instances might be cited, but the above will suffice to show the necessity which exists for accepting with the greatest caution any conclusions based on a few results of accidents or experiments—and not too readily accepting the view, that because a certain quantity of an explosive material burns harmlessly away, therefore the same, or a less, or possibly even a larger quantity would behave in the same way under all circumstances.

The fact is, that very minute variations in the conditions may make the difference between explosion and fire only, as was very strikingly shown at the Eastbourne experiments above referred to, when a slight difference in the thickness of the boxes made the difference between an explosion and a fire.

The sound view to take is to accept the conclusion as establishing merely a probable and useful margin of safety, not too narrowly to be encroached on, but one which, while it affords a reasonable expectation of fewer serious accidents, does not justify any diminution of precaution.

Woolwich.

An accident, fortunately unattended with serious consequences, is stated to have occurred at Woolwich on 21st June, during the inspection of the Royal Horse and Field Artillery. One of the 12-pr. batteries had recently returned from a course of target practice at Okehampton, and it appears that a shrapnel shell remained undischarged in one of the guns. On coming into action the gun was fired, the shell struck a large elm tree; it passed over the Royal Military Academy and two ranges of buildings in the rear, eventually falling harmlessly into a road near the cadets' workshops.

The gun's line of fire was in the direction, it was stated, of some houses occupied by staff officers, but the tree interposing deflected the projectile.

Chattenden.

An accident occurred at Chattenden on 28th September, during the Volunteer Manœuvres, by which Sergeant J. Cowley, a volunteer, met his death. The sergeant

* Report on the Stowmarket Explosion by Colonel V. D. Majendie, 9th September 1871, pp. 17, 18.
† *See* Special Report XLV., dated 28th November 1882.
‡ Special Report, No. XLIV., of 9th December 1882.
§ Annual Report for 1884, pp. 55, 56.
‖ Report and proceedings of Select War Office Committee on Guncotton, &c. (1871–74), pp. 10, 11.

was told off to fire a charge of 40 pounds of gunpowder to blow down a stockade 2 feet thick and about 7 feet in length and height, the whole being supported by timbers. Three feet of safety fuze, supposed to burn about 75 seconds, was used. There was a casemated shelter some 155 yards distant for the protection of the men during the explosion. The sergeant, however, probably to obtain a better view of the explosion, ran slowly in an opposite direction, and although he reached a hedge before the explosion occurred, he was found directly afterwards, lying on the ground severely injured about the face, probably by splinters or a piece of hard clay.

H.M.S. "Blanche."

A serious accident occurred on the 10th December on board Her Majesty's ship "Blanche," at Simon's Town, while saluting the admiral's flag. Several shots had been fired, and as the charge was being placed in the breech of one of the guns for the next round, it ignited and an explosion immediately ensued. One of the crew serving the gun had his left arm shattered, and his face and eyes were dreadfully injured.

Another man was wounded in the head, and it was feared that he would lose his sight, and several others sustained injuries of a less severe character.

Foreign Explosions.

Foreign explosions.

Following the practice of former years, we proceed to give a brief account of the more interesting foreign explosions which have come under our notice. As we have remarked in former reports, our information as to these accidents is necessarily very incomplete, and often gleaned only from the briefest notices in newspapers.

In some instances, however, through the courtesy of the persons concerned, through the Foreign Office, or from other sources, we have been able to collect details which are interesting and often valuable.

As in former years, we are much indebted to General Abbott, of the United States Army, who has furnished us with much information as to American explosions.

In the following list the countries are arranged in alphabetical order; the more trivial explosions have been omitted.

Africa.

Matadi.

There appeared in the newspapers in January, the particulars of a disastrous explosion of dynamite and gunpowder, which occurred on the railway which runs from Matadi on the Congo, and which seems to have been the second explosion which had occurred on the line within a short period.

It was stated that a train, conveying both Europeans and natives, left Matadi for Emposi, the latter being situated about 12 miles up the line. On reaching Emposi, the engine-driver was instructed to return and to pick up a wagon which had 54 boxes of dynamite and 82 barrels of gunpowder.

The wagon was on the line about two miles and a half from Matadi, at which latter place the explosives were required for blasting purposes. From some cause not stated, the engine descended at a rapid rate, instead of approaching slowly, the result being that it dashed into the dynamite wagon with great force. The explosion which followed was heard for miles. The car with the explosives had disappeared, and in its place was a huge excavation like a ravine. The rails of the line were much twisted and bent.

The engine itself was turned completely round, and altogether destroyed, whilst piled on top of it were the carriages containing most of the passengers.

Three of the white officials were killed on the spot, whilst a fourth, the head of the Société Anonyme Belge, succumbed to his injuries on the following day.

It was at first computed that about 20 blacks had been killed outright, but on a count being made the following day, 26 others were missing.

The local press commented very strongly on accidents of such appalling dimensions following closely upon others in America and elsewhere, and upon the constantly recurring accidents from dynamite in Kimberley and Witwatersrandt, and urged that the Government should take action in the matter.

Johannesburg. Barrett Reitfonten property.

Two accidents occurred in boring into unexploded dynamite cartridges, by which one Kaffir was killed and two others were severely injured.

New Crœsus Mine.

On the same occasion (date not given), a similar explosion took place at the New Crœsus Mine, whereby a native had one of his arms and one of his legs blown off. He died soon after being admitted to the hospital.

America.

An explosion occurred on 9th January in the factory of the American Forcite Manufacturing Company, in a shed situated about half a mile from the main building. It took place in what is known as the "dope" mill, at which a number of workmen were employed in making a brown composition, which, it was stated, would burn without exploding. In this shed was stored, ready for shipment, about 10,000 pounds of forcite packed in cases. Forcite powder factory, Lake Hopatcong, N.J.

The accident was attributed to the fact that the machinery, with which the mixing was done, was being worked too rapidly, and that owing to the increased amount of friction the mixture took fire.

The stuff burnt slowly, and thus gave the workmen a chance of escaping to a place of safety, and gave the material a chance to burn itself out.

An explosion followed, fortunately without causing loss of life or personal injury, but resulting in a loss estimated to amount to 1,000 dollars.

It was claimed for the Company that they have no more than the average number of explosions due to the manufacture of high explosives. It appears, however, that they had a very bad accident in March 1892 (the result of which was not stated), whilst another accident which occurred two days after the Christmas of 1891, is credited with the loss of two lives, and an accident, involving the loss of several lives occurred some three years before the last-mentioned one.

They are stated to have now reduced the number of men in each building, and have taken other steps towards reducing the risks involved in their manufacture.

It appears from further particulars which have been published that the number of persons who were injured by the explosion at Messrs. Deihl's Firework Factory on the 30th January 1892,* amounted to about 50, and that in many cases the injuries were likely to prove fatal. It was also stated that 10 houses were set on fire by the accident, but no fuller details, however, are recorded. Cincinnati.

On 28th February a quantity of gunpowder exploded in a store situated on the first floor of the hotel Benton, in Pine Street, blowing out the front of the building, badly shattering other portions of the same, and breaking all the plate glass in the vicinity. About 3,000 cartridges, which stood in the rear part of the store, exploded, the bullets, it was stated, scattering in every direction, the store was set on fire, and one person was seriously, if not fatally, injured. The occupants of the hotel, however, escaped without injury. St. Louis.

On the 8th March an explosion took place in the corning mill of the Laflin Powder Company at Laflin, completely wrecking the building, and doing great damage to adjoining outhouses. One man (the only one in the mill at the time) was instantly killed; whilst the loss to the Company is estimated to have amounted to several thousand dollars. The cause of the accident was not ascertained. Wilkesbarre, Penn.

On 14th March an explosion occurred at Mine No. 1, owned by the Choctaw Coal Company at Anderson, Indiana, by which nine out of the 18 persons in the mine were killed, and several others received injuries which, it is stated, will probably prove fatal. The accident was caused by the premature explosion of a blasting charge. Anderson, Indiana.

On 18th March an explosion, resulting in the loss of two lives, took place in a building which was being temporarily used as a blacksmith's shop, on a park site a mile east of Scarsdale, and which was intended for shoeing horses, sharpening tools, &c. for the work of excavation being carried on at the place. The two men who were killed were in the shop at the time; their bodies were hurled a distance of 200 feet, and the shop was blown into splinters. Although there was no doubt that the explosion was caused by dynamite, the foreman stated positively that no dynamite was kept in the shop. Harlem Railroad, near Scarsdale Station.

Two Italian labourers, working on the New York and Harlem Railway, quarrelled over a trifling matter on 18th March, and soon came to blows. Scarsdale, West Chester County.

They were engaged in blasting, and one of them had in his possession a packet of dynamite cartridges. In struggling with each other the men fell to the ground, exploding the packet of cartridges; and, according to the newspaper, both men were

* *See* Annual Report, 1892, p. 46.

literally blown to atoms. It is almost incredible that the accident could have happened unless the cartridges were fitted with detonators.

On the Colorado Midland Railway.

On 18th April an explosion occurred at the Buck Ivanhoe Tunnel, on the line of the Colorado, about 18 miles west of Leadville, by which five men were killed and several seriously injured. The extent of the damage could not be estimated at the time. The cause of the accident was attributed to the ignition of the powder by the turning on of a current of electricity, but fuller details were not forthcoming.

Chicago.

On the 24th April the armoury belonging to the 1st Regiment of Militia was completely destroyed by fire. During the conflagration several explosions took place, presumably of cartridges stored in the magazine, and the walls of the armoury were partly overthrown. The loss is estimated at $250,000.

New York.

On 10th May, as some workmen were engaged in removing the débris resulting from some blasting operations at Amsterdam Avenue and Ninetieth Street, one of them struck a dynamite cartridge with his pick, and the explosion which followed seriously injured three of them.

On 22nd May an explosion occurred on a hill near Clinton Dynamite Works, about two-and-a-half miles from the village of Haverstraw. When the dynamite works blew up a few months previously, one old tank was left standing on the hill above the building. A few pounds of dynamite remained in it, and some of it (evidently nitro-glycerine which had exuded), it is stated, ran through on to the stones. The heat of the sun set off the "dynamite," and the tank was blown high in the air.

New York Harbour.

On 26th May the breech of one of the guns of the "Santa Maria" was blown out while firing a salute in honour of the Infanta Eulalia, who was inspecting three Caravels at their anchorage. The fragments injured a lieutenant and a seaman on board.

West Hoboken.

On 15th June an explosion occurred at Summit Avenue, West Hoboken, by which one man was seriously, probably fatally, injured, and several others were also injured. Several houses were demolished, and others badly damaged, whilst several persons had narrow escapes.

It appears that a number of workmen were engaged in excavating for a sewer, and were putting their tools into a large box which stood in a vacant lot a few yards from the side walk. In this box were 15 dynamite cartridges, all of which exploded simultaneously, but whether this was caused by the act of throwing a lighted match by one of the men in lighting the night-lamp, or by the tools being thrown into the box, did not transpire. It was claimed that the city officials were negligent in allowing the cartridges to be used in such numbers in such a careless manner.

Goat Island.

A fire broke out in the guncotton factory at the Government Torpedo Station, on Goat Island, on the 3rd July. The workmen employed in the factory immediately commenced removing a large quantity of the cotton to a place of safety, but before they had finished, they were overtaken by the flames and the cotton exploded. The factory was completely wrecked. Two men were killed and three, including an officer, were injured.

Kingston.

On 5th July, during a very severe thunderstorm, a powder-house, a low brick building belonging to the Schaghticoke Powder Company of Buffalo, which is a branch of Laflin and Rand, in the Second Avenue, on the outskirts of the city, was struck by lightning. An explosion followed, and the powder-house, which contained 50 kegs of blasting powder, was blown to atoms; fence, rails, stones, and bricks were scattered for half a mile.

A three-storey brick tenement-house, about 100 feet from the powder-house, was badly wrecked by the explosion, and all of the inmates were injured, some of them most seriously. The concussion split the roof from end to end, doors were thrown from their hinges, windows were shattered, and the walls throughout the house fell. A house on the hill, at the back of the powder-house, was also badly wrecked. The telephone system throughout the city was disabled, and the electric lights were extinguished.

Denver, Colorado.

On 10th July, about 8,000 lbs. of dynamite, in a storage-house in South Denver, exploded, the shock extending throughout the entire city. There was a general destruction of window panes, and many doors were blown from their hinges. Two men are supposed to have been blown to pieces. Particles of clothing and a revolver

were found near the scene. The cause of the accident was not ascertained, but it was believed to have been the work of tramps.

Coney Island.

On 11th July an explosion occurred at Coney Island in one of the buildings of the Gravesend Plant of the Pain Fireworks Company, by which two men were seriously injured, and the building blown to pieces.

The accident happened just as the workmen were leaving work for the day.

The two men injured were the only ones in the building at the time, and it was stated that they were engaged in loading a 16-inch firework shell.

The shell exploded, the roof was blown off, and the two men were knocked against the walls and then on to the floor. They were only rescued with much difficulty.

The Pain plant is situated near Parkville on the old Coney Island Road, and consists of about 40 buildings 50 feet apart. The building caught fire almost instantly, and it was with great difficulty that the flames were prevented from spreading to the other shops.

The cause of the explosion, although unknown, was supposed to have been due to one of the men smoking; it was stated, however, that the Company prohibit smoking and take every precaution for the prevention of accidents.

Huntingdon, Indiana.

On 24th July, as two men were shooting with a rifle, a bullet entered the window of Schaeffer and Schaeffer's powder house; the resulting explosion blew both of the men to pieces. Houses were wrecked all round, and several persons were injured.

Pittsburg, Penn.

On 27th July, M. S. Van Buren and his two brothers went to their magazine, near Samples Station, on the Pittsburg and Western Railway to get a load of nitro-glycerine for the purpose of shooting an oil well. They were engaged in loading a waggon with the stuff, and had placed a considerable quantity in it, when, in some manner not explained, the nitro-glycerine exploded. M. S. Van Buren was blown to atoms, only part of one leg being found. The three horses attached to the waggon were also blown to fragments, while only a few fragments of the waggon remained. The brothers, who were near by, escaped injury.

South Acton, Mass.

On 29th July, No. 2 Corning Mill of the American Powder Company blew up. One man was instantly killed. The explosion was very severe, and broke most of the glass in buildings near the mill. There were about 2,500 lbs. of powder in the mill at the time. The cause of the accident was not ascertained. Last year the Company had two mills blown up.

Orville.

A freight car loaded with dynamite, when about seven miles from Orville, on the Pennsylvania Railway, exploded on the 9th October. Five men were killed. The shock occasioned by the explosion, it is stated, was felt 10 miles away. The other cars of the train were blown across the metals.

Emington, Illinois.

As some men were engaged, on the 17th October, in boring a well, which had already reached a depth of 305 feet, and which was intended to supply the city with water, a premature explosion of dynamite occurred. Five of the men were killed, and five injured, two of the latter fatally. It appears that two of the men, to further their work, filled a gaspipe 2 feet long and $1\frac{1}{4}$ inches in diameter with dynamite, and that, while tamping it, the charge exploded with the above results.

Rio de Janeiro.

For some time after the revolutionary war broke out in Rio Janeiro it was stated that Englishmen were not allowed ashore, but on the removal of this embargo about the month of October a party belonging to Her Majesty's ships "Beagle," "Racer," and "Sirius," went ashore to dig for sand. They approached too closely to a powder magazine, which exploded. From a reply to a question which was asked in the House of Commons, it appeared that the Brazilian Minister for Foreign Affairs had informed Her Majesty's Minister that inquiries had been instituted by the police, and it seemed that some workmen had lit a fire near the door of one of the magazines, and that the insurgents were removing ammunition, and that some sparks from the fire ignited some loose powder. The explosion resulted in the deaths of three naval officers belonging to H.M.S. "Sirius," one belonging to H.M.S. "Racer," and an able seaman of the "Sirius." Five other seamen were injured. The magazine was situated about 150 yards from the beach where the party was obtaining sand, and probably contained 100 tons of powder; the flame from the powder magazine set the shell store also on fire.

New York. On 7th November, Dittmar's Dynamite Factory, near West Chester, was entirely demolished by an explosion. The factory building consisted of a large low framework structure. No details were given as to the cause of the accident, or whether the disaster was attended by loss of life or personal injury.

Accident in 28th Street, New York. An accident (no date given) occurred at West Twenty-eighth Street, to a workman, who it appears was engaged digging a vault in the cellar of a dwelling-house (which latter was about to be converted into a factory building). It was stated that he took a dynamite cartridge from a barrel of cartridges, and laid it on the rocks upon which he was working prior to charging the blast. Suddenly there was an explosion, and the man was seriously, probably fatally, injured. The details are meagre, and afford no clue as to how the accident was brought about. The building, however, was not damaged.

Austria.

Vienna. What is described as a "terrible explosion" took place on the 1st August in a laboratory connected with the Austrian War Office.

In this building chemical and technical experiments with projectiles and explosives were constantly going on under the auspices of the Military Committee. On the morning in question, while a projectile was being filled with a new description of explosive, called Ecrasite, manufactured by Mr. Nobel, the inventor of dynamite, the accident took place. One sapper was killed on the spot, while several others were seriously, and some were fatally, injured.

A civilian who happened to be passing by the building at the time was also injured by a fragment of the exploded shell.

Persons in the second storey of the building were dashed to the floor by the unusual atmospheric pressure, whilst all the windows in the neighbouring houses were broken.

Ecrasite is the new explosive recently introduced in the Austrian Army, viz., in 1891, the basis of which is picric acid, and it was to be used for blasting as well as for filling shells. It has been hitherto claimed for it, that it was inexplosible by ordinary percussion, or even contact with flame, and that it could only be ignited by specially prepared detonators.

It was further stated that the comparatively slight amount of damage was due to the fact that there was only one-fifth of a kilogramme of the compound stored in the laboratory.

Australia.

Australia. Among the foreign explosions, of which we have obtained information, was one at Melbourne on the 24th October 1893, which proved fatal to an inventor of explosives, a Mr. Liardet, while experimenting with, or manufacturing for experimental purposes, an explosive (called "Acme" powder) of his invention.

Particulars of this accident have been obligingly supplied to us by Mr. C. Napier Hake, Chief Inspector of Explosives for the Colony of Victoria. The explosive consisted of an admixture of picric acid, chlorate of potash, nitrate of potash, and tar; and had been submitted to Mr. Hake officially for approval, and by him rejected as "too dangerous for practical use."

The unfortunate inventor had expressed unbounded confidence in the value and safety of his explosive, thus adding another to the many examples which could be given of the fact that on these points an inventor is not, as a rule, the best judge.

China.

Nigama. A brief announcement appeared in the papers that a French man-of-war was blown up at Nigama, on the China coast, during the month of May. The explosion set fire to the village, destroying 60 houses as well as two junks anchored in the port, which drifted into collision from their moorings, whereby 17 people lost their lives.

Sam Yuen Lee. An explosion, which was reported to have occurred at the Government gunpowder factory at Sam Yuen Lee, near Canton, probably some time in August, was credited with the demolition of 1,000 houses, and the killing of about 5,000 persons. The roundness of the numbers in both items is suspicious; and probably considerable reductions may be made on account of exaggeration.

France.

What was stated to have been an accidental explosion occurred on 1st January at a house in the Avenue de Jena. The concierge, who was in charge of the place, was putting coals on a fire in the kitchen range, when something exploded, doing a great deal of damage. The concierge was knocked back against the wall, but received no injuries. It was supposed that a portion of a cartridge was in the coal, which latter came from a district where explosives are much used in mining. Paris, Avenue de Jena.

An explosion of some unknown material occurred on 11th July in a house in the Rue Sebastopol, where a number of workmen were engaged. A man was seen to place a covered basin in the kitchen, and on one of the workmen going to see what it contained, a violent explosion followed, injuring one workman. Beziers.

On the 14th July a man who was retailing in the streets a cracker or "throwdown," went into a shop with a packet of twelve dozen, which he put on the floor while he lighted a cigarette. He let the lighted match fall upon them, and an explosion ensued by which three persons were injured. Paris.

On July 25, 1893, at 9 a.m., several explosions took place in the following parts of the Dynamite Factory at Ablon, *i.e.*, the nitration, filtering, and incorporation laboratories, Nos. 36, 38, and 39. Explosion at the dynamite factory at Ablon, Honfleur.

The first was very violent, demolishing the greater part of the buildings, and covering the whole establishment with wreckage; two other feebler shocks followed at short intervals, and, finally, after sufficient time had elapsed for help to arrive, a fourth entirely destroyed the incorporation room.

Portions of the wreckage being in flames, it was feared that fire would break out in several of the buildings, but, after the wounded had been removed this was ultimately, though with great difficulty, prevented. In the "slow-separation" room this was a particularly difficult and dangerous task, as it contained several vessels in which the nitro-glycerine becomes finally separated from the acids; the explosion of these was prevented, but in No. 36, the two nitration apparatus, one of which was empty, and in the course of being repaired, had been thrown to the foot of the "Mound" without being entirely demolished, and the second of the two, which had been in use that day exploded at 1.40 p.m., but produced a comparatively feeble detonation.

The first series of explosions had killed eight persons, ten other workmen were seriously hurt, and amongst them three, who after the first shock had escaped from the incorporation room.

When the extent of the damage had been estimated, it was stated that on the site of the filtering room there was a cavity about 3 metres deep, the slopes of which were covered with wreckage of planks from the buildings which had been exploded, and which were built of wood, with a roof of bitumised pasteboard.

In No. 36, the ground had been torn up, but did not present any very deep cavity, and a small excavation at the foot of the left "merlon" showed the place of the nitration apparatus which had exploded. The other apparatus was still lying half demolished a little further at the foot of the "merlon."

In the incorporation room, No. 39, there was an excavation stretching to the right, all over the place occupied by the kneading troughs in that part of the room. To the left the broken soil was covered with bits of lead torn from the troughs.

The buildings Nos. 35, 37, 40, 54, and 55 were completely wrecked, and all the other buildings of the line of the cartridge houses, and of the magazines suffered more or less, but still the effects of the explosion were less serious there than in the groups of machine houses, the laboratory and the shops for the fabrication of nitric acid, where the walls were thrown down, and the ceilings and wooden partitions and all the woodwork were either displaced or destroyed.

According to the information received from the director of the factory and from the foreman of the works, at the time of the explosion ten operations of nitration had been made, giving 1,100 kilos of nitro-glycerine; the nitration house would still contain perhaps between 500 and 600 kilos, about 400 would be in the filtering room, and the rest had been moved into the incorporation room, which contained altogether about 600 kilos of dynamite (86 per cent. nitro-glycerine).

From the state of the different sites, and the order of succession of the several explosions, it does not appear that the initial explosion can have originated in the nitration room. Had it been so, it is nearly certain that the 500 or 600 kilogrammes

it contained would have detonated at once. In which case the two nitration apparatus would not have remained intact, and a pretty deep cavity would have been found on the site of the vats.

All the indications showing that the first explosion was the most violent, it follows that it must have taken place in the filtering room, where the explosion of the 400 or 500 kilogrammes it contained caused the deep cavity mentioned above, wrecking at the same time the two neighbouring buildings, destroying the apparatus, and dispersing their contents in a greater or less degree.

When fire broke out amongst the wreckage, the nitro-glycerine in the nitration room exploded, but only partially, and the same thing occurred in the incorporation room, where the line of kneading-troughs on the left, nearest the filtering room, would have given rise to the first explosion, of which the traces had subsequently been covered by the wreckage consequent on the partial detonation of the dynamite in the right-hand troughs.

It is difficult to say what the cause of the explosion was originally; it has been suggested that as all the apparatus was provided with earthenware taps, these, in spite of the precaution of their being always smeared with vaseline, may have caused friction sufficient to provoke an explosion.

St. Medard. A powder magazine at St. Medard, near Bordeaux, blew up on the 20th October with a terrific report. It was found that one man had been killed and at least two injured; but it is believed that there were other persons about the building at the time of the accident, and an active search was made among the ruins by the authorities.

Girenchy. A brief account of an accident at Girenchy, whereby several persons were killed and injured by a dynamite explosion appeared in the papers, but no details were given.

Germany.

Spremberg. A terrible explosion is stated to have occurred at Spremberg, in January, at a cartridge factory, by which six persons were instantly killed, but the nature of the explosive was not mentioned.

Heranthals. An explosion occurred in a dynamite factory at Herenthals, owned by an English company. Two men were killed and several others injured, and considerable damage was done to the buildings.

Ironclad "Baden." An accident resulting in the death of two officers and seven men, and from 16 to 18 men severely injured, but, fortunately, none of them fatally, and a number of others less severely injured, occurred on board the German ironclad "Baden" during artillery practice at Friedrichsort, near Kiel, on 3rd August. Opinion as to the cause of the accident appears to be somewhat divided; one view being that it was due to the breech-closing arrangement not being properly secured, whilst another inclines to the belief that the accident was owing to the remains of a smouldering cartridge remaining in the gun. It was stated, however, that the cartridge which exploded was a twenty-six centimetres, containing 107½ lbs. of gunpowder, and that it was placed in the gun, but when the latter was fired the shell did not leave the barrel, but the closure wedge was hurled with terrific force backwards, so that a lieutenant and one of the gunners were literally torn to pieces. The effect of the explosion was described as being terrific, the mangled corpses disfigured beyond recognition, clothes set on fire within the vicinity of other cartridges which it was feared might also take fire at any moment. The fire was immediately extinguished. The shell remained in the barrel about a foot from the muzzle.

Greece.

Government magazine at Scaramanga. An explosion occurred at the Government magazine at Scaramanga in Greece on the 16th June 1893. From the report received, it appears that great carelessness and slackness prevailed in the magazine, the officers and soldiers walking about with their swords and spurs on. At the time of the explosion, gunpowder or ammunition was being packed or unpacked in the magazine, and the accident is attributed to the use of some non-regulation implement.

Fifteen persons, including two officers, were killed, and two persons (including an officer) were injured.

The magazine consisted of four buildings, the contents of all of which exploded.
The total quantity of powder amounted to 127 tons, but the radius of effect was small, owing to the fact that a large proportion of the powder was contained in small-arm cartridges.

Holland.

Minden.

An explosion occurred on the 15th November at the gunpowder works at Minden. The number of victims was not known, but it was expected to have been considerable. Two bodies were extricated from the ruins of the wrecked buildings, which latter covered an extensive area. The cause of the accident was not recorded.

Italy.

Palermo.

During a display of fireworks held at Palermo on 14th July, in honour of the festival of Santa Rosalie, four persons were killed and seven others injured by the bursting of a mortar.

India.

Explosion of a magazine at Matoonga, Bombay (1891).

We have obtained through the India Office a copy of the report furnished by the Committee appointed to inquire into the circumstances connected with the explosion of a magazine at Matoonga, Bombay (Antop Hill) on the 28th December 1891, and referred to in our Report for that year.* From this report it appears that the magazine contained at the time of the explosion, 17,450 lbs. of blasting gelatine, and 5,450 lbs. of dynamite, making together 22,900 lbs., or nearly 11½ "tons." The magazine in which the explosion occurred was substantially constructed with walls of stone, laid in lime mortar, with an arched roof. It appears that "early on the "morning of the 28th December 1891, the watchman observed smoke issuing from "the ventilators of the magazine, and as the smoke increased, the men ran away, and "shortly after this the explosion occurred. One of the watchmen ran to the nearest "police station, a distance of about 1,000 yards, and had just arrived at the station "as the explosion took place; so it may be reasonably assumed that between the time "when smoke was first observed and the explosion could not have been less than "10 to 15 minutes, but there is no evidence as to how long a time the burning had "been in progress inside the building before the smoke was discovered."

The Committee reported as follows:—

"There is no reason to suppose that the explosion was due to other than accidental causes, and the opinion of the Committee is, that some of the explosives (probably some of the blasting gelatine) had become unstable, owing to decomposition, and that there was spontaneous ignition of some case or cases; that the effect of the burning in an enclosed building was to heat some portion of the explosives to a temperature approaching their exploding point, and that eventually the fire inside the magazine ended as it was bound to under the circumstances."

With this conclusion, so far as the information at our disposal entitles us to judge, we are disposed entirely to agree.

This makes at least the fourth instance of an explosion of a magazine from the spontaneous decomposition of blasting gelatine preparations which has come under our notice, viz., the two explosions which occurred in 1888 at Aden,† and the explosion in April 1890 at Shelabagh, on the Sind-Peshin Railway.‡ Indeed, it appears to us, as we stated in our Report for 1890, extremely probable that two other previous explosions on the Sind-Peshin Railway (at Nari Gorge and Kach) were due to the same cause, in which case the explosions now under notice would constitute the sixth explosion known of this character in hot climates.§

The extent of the damage does not appear to have been very serious. There was a neighbouring magazine within about 60 yards of the exploded magazine, which contained 27 tons of gelignite and dynamite. This magazine had its roof, doors, and windows damaged.

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* Annual Report, 1891, p. 52.
† *See* Annual Report, 1888, pp. 45–47.
‡ *See* Annual Report, 1890, pp. 51–52.
§ Colonel Caldecott, R.A., Superintendent of the gunpowder factory at Kirkee, and a member of the Committee, unhesitatingly includes the two earlier Sind-Peshin explosions as cases of spontaneous explosion of blasting gelatine.

It appears from the report of the Committee, that some of the blasting gelatine which exploded had been in stock three years and seven months, and it is rather remarkable that the age of some of the blasting gelatine which exploded at Aden in 1888 was almost exactly three years.

The circumstances connected with this explosion have led the Indian Government to refer certain matters relating to the situation and construction of the magazines at Antop Hill and the amount to be stored therein to this Department, and we have also been called upon to advise as to the periodical examination of the nitro-compounds stored in such magazines. There can be no doubt whatever, that it is a paramount condition of safety in regard to explosives of this sort, that they should be periodically examined, more especially in the case of gelatinous nitro-glycerine compounds, the behaviour of which (as abundantly appear from the facts which we have recited) when stored in hot climates for any length of time, is very far from being above suspicion. And we have little doubt that one result of this accident and of the report which we have felt it our duty to furnish on the subject, will be the establishment of a systematic examination by competent and independent officers of all nitro-glycerine compounds that are stored in India and other tropical dependencies.

S.S. "Delcomyn" *en route* for India.

In our Annual Report for 1891*, we gave such particulars as we had then received on the destruction by fire, without explosion, of a quantity of safety cartridges belonging to the India Office on board the S.S. "Delcomyn" *en route* for India, and a reference to our report will show the peculiar interest in this case arises from the fact that although an enormous number of cartridges were destroyed by the fire, there was nothing approaching an explosion *en masse*. The experience in this case was on such a very large scale, that we deemed it advisable to obtain as full details as possible for future reference, and the Director-General of Stores, India Office, has kindly and obligingly furnished us with the following particulars:—The total number of Snider cartridges shipped on the vessel in question, was 1,000,160 in 1,786 boxes, containing 560 cartridges each. Of this number, 22,399 cartridges in 40 boxes of 560 (less one cartridge†) were recovered unexploded, 333,760 cartridges in 596 boxes containing the same number were jettisoned, and 644,001 cartridges were destroyed by fire. Except perhaps in the case of the great Antwerp explosion of 1889, we are unaware of any case where so large a quantity of safety cartridges were exposed to the action of fire, and the result confirms satisfactorily the opinion which we expressed in our 1891 report, that we are entitled to regard without the slightest anxiety, and to accept as entirely sufficient the modified precautions in storage and transport which we have deemed sufficient for the protection of the public in the case of safety cartridges.

Russia.

Kasan.

A serious accident is reported to have occurred on 30th January at a smokeless powder factory in Russia. While a number of workmen were engaged in the drying room, 13 cwt. of guncotton exploded, killing three persons on the spot, and severely injuring another. One man who was buried beneath the débris was extricated, and was found to have escaped uninjured.

Dobraja Nadeshda.

A fatal accident occurred at Dobraja Nadeshda, in the district of Taganrog, owing to the explosion of a shell, dating back to the Crimean War, which was found embedded in the ground at that place. A man, wishing to examine its interior, struck the shell heavily with a hammer, with the result that it exploded with terrible force. Nine persons standing close by were killed instantly, while several others were severely injured.

Spain.

Morro, near Bilbao.

On 11th January at Morro, near Bilbao, two men were killed and another man severely injured whilst warming themselves at a fire which they had made in a shed in which a quantity of dynamite cartridges was stored.

The frozen cartridges, whilst thus being thawed, exploded with the results stated above.

Santander.

On 3rd November one of the most terrible disasters of modern times occurred at Santander.

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* Annual Report for 1891, p. 44.

† Exploded.

The Spanish steamer "Cabo Machichaco" (an English-built vessel of 1,213 tons register), belonging to the Vasco Andulaz Company, arrived at the port, having on board a general cargo consisting of 2,000 tons of iron, many cases of petroleum, a few barrels of wine, and some sacks of flour for ports along the coast, and had, amongst other merchandize addressed to the port of Santander, 30 cases of dynamite.

Before reaching the quay, where through some fatal and strange oversight on the part of the responsible authorities, the ship had obtained permission to unload in direct contravention of the harbour regulations respecting vessels with explosives on board, she was found to be on fire, and, astounding to relate, was allowed to be moored to it.

The 30 cases of dynamite were quickly unshipped and removed to a place of safety on shore.

The agent was asked whether there was any more dynamite on board, and in order, it was supposed, to prevent the removal and probable scuttling of the vessel he answered in the negative. It speedily became apparent, however, that such was very far from being the case.

There was, in fact, a further enormous quantity of dynamite on board, amounting to about 1,780 cases of 25 kilos each, or about 46½ tons (of 2,000 lbs. each) which was not declared, it being the custom in Spain to declare only the portion of a cargo intended for the port of entry.

In the meantime the quay was crowded with spectators to watch the burning ship, amongst whom were the Civil Governor of the Province, the 1st and 2nd Commandants of Marine, their adjutants, the Chief Engineer of the Harbour Works, the Municipal Judge, the Colonel of the regiment stationed there, and other leading officers, several of the principal inhabitants, merchant captains, including the commander and mates, with 60 seamen, of the transatlantic mail steamer "Alfonso XII.," the civic firemen, and a number of police, together with 200 civil guards and troops.

The fire gradually spread, and ultimately (about 2½ hours after the outbreak of the fire) a tremendous explosion took place, with the most awful results. Not only was the steamer blown up but also part of the quay, including the majority of the persons enumerated above.

Spars, rails, indeed all sorts of fragments were hurled in every direction, killing and injuring people at considerable distances.

Some buildings were set on fire by burning débris, and very serious damage was done to a great part of the town, to ships, quays, &c.

In one instance, a piece of iron, "about the size of an ordinary sized chest of drawers," is stated to have been hurled a distance of a quarter of a mile from the quay over the housetops, fortunately without striking the house in front of which it ultimately came to rest, and which was occupied at the moment by the British Vice-Consul and his family.

It would be unprofitable to reproduce here the appalling and often hysterical accounts of this disaster which appeared in some of the newspapers of the day, to set forth the many sensational incidents to which it is stated to have given rise, or to dwell on the horrors with which it was doubtless accompanied.

Our efforts have rather been directed to ascertaining as accurately as may be for the purposes of reliable record and comparison the exact details of the affair, and with this view the Foreign Office was moved to obtain some such trustworthy particulars as might be available from the British representatives at Santander and elsewhere.

Although we have been favoured with a great deal of useful information, the fact that it has not been collected by an expert very considerably impairs its value in several directions, and we regret now that we did not, in view of the almost unique magnitude of the disaster, seek permission for one of us to visit Santander, and there personally institute inquiries.

However, we must now content ourselves with such information as we have been able to collect at second-hand.

As regards the quantity that exploded, it can hardly, we think, have amounted to more than about 66,000 lbs. (distributed in 1,200 cases of 55 lbs. each) = 33 "tons."*

* The difference between the amount on board (1,700 cases) and the amount exploded (1,200 cases) was the amount in the after hold, which all escaped explosion, and which the account we have adopted represents at 500 cases. But other accounts give slightly different figures, viz., 1,237 cases in the fore hold, and 463 cases in the after hold. If this account be accepted, the maximum amount exploded must be stated at 68,035 lbs., or about 34 "tons." The difference, however, is comparatively unimportant. Another account gives the total on board at 1,720 cases (55 lbs. each) of which 700 (in after hold) did not explode. This would give 28 tons exploded.

And it must for ever remain unknown whether the amount which actually exploded was as much as this, for—

1st. It is conceivable that *some* portion of the dynamite in the fore-hold may have been consumed by fire before the explosion, but this, in any case, is unlikely to have been a large quantity, for we know from the experiments at Llanberis in June 1872 that so small a quantity as 6 cwts. of dynamite cannot be relied on to burn without explosion.*

2nd. We have no certain information as to whether any portion of the dynamite in the fore-hold was recovered unexploded. We should think it extremely improbable that such could be the case, having regard to the tremendously powerful initial explosion (so to express it) which was established by the explosion which actually occurred.

We think, therefore, that it may be safely assumed that the amount actually exploded did not greatly, if at all, fall below about 66,000 lbs. = 33 "tons."

As regards the damage done, this has to be considered under two principal aspects:—

(*a.*) Loss of life and personal injury.

(*b.*) Injury to property.

With regard to loss of life, we are unable to say with certainty how many people were killed, but in a despatch, dated 14th December, the British Vice-Consul at Santander (Mr. Leopold March) says the number killed (including those who have succumbed to their injuries during the last month) was 510. Of the number injured we have no reliable estimate. One account places it at "about 2,000."†

With regard to injury to property, this was necessarily very great indeed, and necessarily also has been impossible to estimate. Nearly all the accounts we have seen run off into what we must characterize as extravagant and sensational descriptions, which are of no sort of use for scientific purposes or accurate comparison.

The local havoc was, of course, tremendous, and the destruction (partly by fire) of some houses on the spot pretty complete. It is also indisputable that débris (in some cases of a formidable character) was projected a considerable distance. The Vice-Consul, for example, states that "several pieces of iron" (he unfortunately omits to state their size or character) "were projected a distance of a mile," while a quantity of iron rails, which had formed part of the cargo of the exploded vessel, were hurled into the air, bent and twisted, together with fractured chain cables, anchors, iron bolts, &c., and descended within a radius of 300 yards.‡

It is, we believe, incontestable that several persons were killed by falling débris, though over what distance the accounts at our disposal are not sufficiently detailed to enable us to say, but we may take it that it was probably not generally beyond the radius (300 yards) which has been mentioned as that over which rails and the more formidable objects were thrown, though no doubt injury from the projected débris was effected over a larger radius.

We have chiefly concerned ourselves with endeavouring to ascertain, with some degree of approximate accuracy, over what area *structural* damage was done, and we caused a definite inquiry to be addressed to the Vice-Consul as to whether any damage of that character (*i.e.*, damage to walls of substantial edifices, as distinguished from mere breakage of windows and the like) was effected beyond the distance corresponding to that which we have set down in the table of distances, as the proper safety zone to be kept clear, and which for 33 tons would be 2,370 yards.

The Vice-Consul replies as follows:—

"The walls of substantially constructed edifices, as well as those of lighter description, sustained no damage.

"This was one of the remarkable features of the explosion, which killing and wounding with its fiery blast and falling débris some hundreds of persons who were standing near, spent its force in demolishing window frames and balconies, displacing and fracturing the partitions, ceilings, and doors of the rooms of houses 300 or 400 yards off, besides breaking innumerable panes of glass, and projecting heavy fragments of iron to extraordinary distances."

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* *See* Report of Gun Cotton Committee, 1871–74, pp. 91, 92.

† Other accounts give the figures at less, viz., 300 killed and 600 injured, but we believe Mr. March's statement of the number of killed is the more reliable.

‡ Other accounts give larger radii of projectile effect. One account which we have received states that "pieces of the ship's hull were thrown 600 metres" (say 650 yards), "an anchor 2 kilometres" (say 2,000 yards), and some machinery 800 metres (= over half a mile).

Other accounts which certainly do not err on the side of minimizing the effects give structural damage as up to 600 metres (= 650 yards).

It is abundantly clear from the above, that so far as protection from structural damage goes, and assuming the amount of dynamite which exploded on this occasion to have been about 33 tons, the distances adopted by us in our Tables and Licenses, and the sufficiency of which has sometimes been impugned, afford a very good and sufficient margin of safety.* Even if we take the lowest estimate of the amount exploded (28 tons), the margin afforded by our tables is very ample, for the radius assigned by those tables for 28 tons as protective against structural damage is 2,045 yards, or over three times the greatest distance at which structural damage to substantial buildings is said to have been done.

New Zealand.

New Zealand.

An explosion occurred on board the barque "Waimea" belonging to the New Zealand Shipping Company, on the 26th April, of which we have obtained some particulars. It appears that a steward, accompanied by an able seaman, were employed cleaning out the lazarette. They had been working with an ordinary lantern, and from some cause, which will probably never be ascertained, an explosion occurred in the magazine situated in the lazarette. At this time the steward had gone forward to the galley, and the seaman was present alone, and was killed by the explosion, and, indeed, no part of him was ever recovered, leading to the surmise that he was blown through the deck and overboard. Another man who was working in the sail locker immediately above the lazarette, was severely injured, and the master of the ship was blinded for several days and otherwise injured. The explosion did considerable damage to the vessel. The magazine at the time contained rockets, blue lights, and, it is believed, about 25 lbs. of gunpowder. The cases containing rockets were said to have been without a lid, and it is quite conceivable that the gunpowder magazine was also open. However this may be, it is probable from some cause or other, one of the rockets or signal lights became ignited, for the captain speaks to hearing a noise "as of a rocket being ignited" just before the main explosion, and that the explosion of the rocket or light ignited the gunpowder.

Miscellaneous Accidents and Occurrences.

Miscellaneous accidents.

Some accidents of a miscellaneous character have come under our notice, to a few of which brief reference may advantageously be made in this report.

Flour Mill explosion, America.

One more case may be added to the instances of flour and malt mill explosions which we have noticed in former reports.†

An explosion of terrific violence was stated to have occurred in a large flour mill at Litchfield, Illinois, on 21st March, by which many of the houses in the immediate vicinity were wrecked, and several persons lost their lives.

The scene of the disaster was the Planet Mill, owned by Messrs. Köhler Brothers, of St. Louis, one of the largest, if not the largest, single mill in the world, having a capacity of 2,000 barrels daily, and giving employment to 150 hands.

The fire was discovered at half-past three in the morning. The flames spread with great rapidity, and were soon beyond control, when suddenly an explosion occurred, owing to the fire reaching the pent up mill dust.

In a moment the immense structure collapsed. The concussion was felt for miles around, and two elevators on the opposite side of the street, also belonging to the same firm, containing 20,000 barrels of flour and 200,000 bushels of wheat, were ignited by the flaming brands hurled through the air by the explosion, and burned to the ground.

A dozen trucks loaded with wheat likewise fell a prey to the flames.

Messrs. Köhler's losses are estimated at $1,000,000, while it was expected that the damage done to other property would reach $150,000.

No fewer than 40 small dwellings were wrecked, and many others slightly damaged.

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* It is a matter of satisfaction to us to be able to record that in the course of an inquiry recently conducted by the Board of Engineers of the United States Army, into the question of the storage of explosives in New York harbour, the Board, after referring in very flattering terms to the work of this Department, proceed to adopt our Table of Distances for the purposes of their inquiry, and speak of "the English practice" as "the "best guide available for deciding such cases as are now under consideration, supported as it is by known "data obtained from the study of the effect produced in great explosions." (Report of Board of Engineers, United States Army, Washington Government Printing Office, 1893, p 89.)

† *See* Annual Report for 1881, p. 54; 1886, p. 57; 1888, pp. 49, 50; 1889, p. 55; 1890, p. 53; 1891, p. 25; 1892, p. 50.

Midlands Goods Depôt, Whitecross Street, E.C.

An explosion which occurred at the Midland Goods Depôt, Whitecross Street, E.C., on the 9th March, brought to light the necessity for some special precautions being adopted in regard to the packing of peroxide of sodium. The explosion, which was fortunately unattended with any serious consequences, gave rise to a fire which was, however, extinguished before any great harm was done; but the fact of a case of goods going off in a goods depôt without any apparent cause, led to the matter being referred to this Department, in view of the possibility of the case being one of surreptitious conveyance of explosive. The article which was being conveyed was peroxide of sodium, and Dr. Dupré, at our request, carried out a number of experiments with this material, and investigated the case very carefully, being assisted also by Mr. Archbutt, the chemist to the Midland Railway Company. The conclusions to which Dr. Dupré came are set forth in a report which he furnished us with on the subject, and, as the character of the material is a matter of importance to all persons who may be concerned in the conveyance or handling or storing of the same, it seems desirable that we should set forth that report here :—

"Peroxide of sodium, Na_2O_2, is a material which parts readily with about $\frac{1}{5}$ of "its weight of oxygen. It is, therefore, a very powerful oxidizing agent, and like "oxidizing substances greatly promotes the rapid burning of all combustible "substances. It differs, however, from oxidizing agents such as nitre or chlorate "of potassium, by the fact that its oxidizing power can be called into action "by water as well as by heat. Thus, a mixture of a combustible with the "peroxide, when merely moistened with water, takes fire or explodes, according to "the intimacy of the mixture. Even if a quantity of the material is merely "placed upon wood, it will, under favourable conditions, set fire to the wood by "the mere moistening with a small amount of water.

"When the wood is once on fire it burns with great fierceness wherever it is in "contact with peroxide, the peroxide melts, and as it flows along the surface it "sets fire to the wood, and thus an intense fire is spread rapidly, and any water "coming into contact with the violently heated mass produces a violent explosion.

"Taken by itself, however, it shows no tendency to explode when moistened with "water, although it becomes heated and steam and some oxygen are given off; "there is not the slightest tendency for the heating or decomposition to spread "beyond the portion actually moistened. When heated it first melts, and on "stronger heating gives off some oxygen, but here also there is not the least "tendency to explosive decomposition. It cannot be decomposed or exploded by "means of a powerful detonator.

"It is, in fact, not one of those substances which are formed by absorption of "heat, and consequently does not give out heat on decomposition, and is therefore "not liable to explosive decomposition by itself.

"Bearing these properties in mind, it may confidently be affirmed that the "explosion at Whitecross Street Goods Station cannot have been caused by the "decomposition of sodium peroxide by itself. It is far less easy to say how "the explosion was caused. This much, however, is clear, that in the first place "one or more of the tins must have been damaged so as to allow access to the "peroxide. Secondly, water or some aqueous solution must have been present in "the box, under such conditions, that by the tilting or turning over of the box, "the water and peroxide came into contact with each other.

"Assuming a sufficient amount of peroxide to have escaped from its tin, the "wooden packing case would take fire. This fire would melt some of the "peroxide, and the melting mass on coming in contact with the water or solution "may account for the first explosion; this explosion would probably break up "some of the tins and liberate more peroxide, which would increase the intensity "of the fire, and further explosions might follow. The tins filled with peroxide "becoming strongly heated, the peroxide would act on the iron and burn it up, "so to speak, with production of a ferrate of sodium, which material would be "scattered about by the explosion.

"That something of that kind has taken place is shown by the fact that the "material found on the platform contains a large proportion of oxide of iron (this "would be formed by the action of water on the ferrate, and its presence cannot "well be accounted for otherwise) and some tin, while the material splashed "against the roof, contains tin, oxide of iron, and particles of metallic iron, in "addition to which some of the pieces of tin plate recovered show signs of "having been acted on chemically. This action of the peroxide on the iron of the "tin plate of the canisters may at the same time account for the disappearance

" of many of the tins; this disappearance may thus not be due to their being
" broken up by a violent explosion, but by being actually burnt up or consumed
" by the hot peroxide.

" The material splashed against the roof, which was examined at my request
" by Mr. Archbutt, chemist to the Midland Railway Company, contains, however,
" more than half its weight of sulphite of sodium, and some sulphate materials
" also found in some of the incrustations on some ironwork near the scene of the
" explosion, which I took away."

In consequence of this report we at once communicated our opinion to the railway companies that they should refuse to accept peroxide of sodium for delivery until the whole question of its proper and safe packing had been thoroughly considered under the advice of their own chemists. It is obvious that in the absence of some strictly precautionary mode of packing serious accidents might ensue.

We may add that peroxide of sodium is not *per se* an explosive within the meaning of the Explosives Act, 1875.

Southampton.

An accident which was described in the press as an "extraordinary explosion" occurred at Southampton on 13th March, while testing an invention for cleaning sewers, by which three men were slightly injured.

The compound which was being employed was supposed to be non-inflammable, of the nature, apparently, of sulphurous acid; it was ignited and placed in a manhole at the head of the sewer, when the sewer gas exploded.

City Road, E.C.

A fire occurred on some premises in the occupation of a medical man at No. 353, City Road, on 22nd March, caused by ether coming in contact with a naked gas jet which was alight in the surgery.

On examination it was found that a bottle containing about half a pound of ether and alcohol had exploded and shattered two other bottles, one of chloric ether, and one of sweet spirits of nitre.

The vapours from the above at once came in contact with the gas jet, which was burning at a distance of about 30 inches from the bottles, and ignited their contents.

The intensity of the fire was increased owing to the melting of the gas pipe which was close to the ether, but the gas was promptly turned off at the meter, and thus the destruction of the premises was prevented. The weather had been unusually warm and bright all day, the ether and alcohol bottles were only about half full, and this added to the temperature due to the burning gas was sufficient, it was believed, to cause the bottles to burst, owing to the expansion of their contents by the heat.

Shoreditch.

An explosion occurred at some chemical works at Charlotte Street, Shoreditch, on 18th August, whilst some chemicals were being mixed in a large tank. One man was seriously injured, and part of the shop attached to the works was set on fire, but was speedily extinguished.

Great Northern Station, Bradford.

An explosion occurred on 8th November at the Great Northern Railway Station, Bradford.

It appears that a boy was conveying two iron cylinders of compressed gas, which were intended for use with a magic lantern, and whilst proceeding along the station subway he let one of them fall. The explosion which followed blew away the greater portion of the lad's chest, head, and arms, but, although many persons were near, fortunately no further injury was inflicted.

Compressed gas (unless used or manufactured with a view to produce a practical effect by explosion, or a pyrotechnic effect, or unless expressly declared to be an explosive by an Order in Council made under the 104th section of the Explosives Act, 1875) does not come within the meaning of that Act; the case, therefore, did not come within the scope of our duties in the shape of an inquiry, &c.

We understand, however, that the testing, marking, and conveyance of such cylinders is occupying the attention of the Board of Trade.

FOREIGN MISCELLANEOUS ACCIDENTS. New York.

On 11th May an explosion of a "soda water tank" occurred near Eleventh Street, New York, whilst being conveyed on a truck. The tank was stated to have a charge pressure of only 700 pounds to the square inch, although certificated to withstand a pressure of 3,700 pounds, and that it came from the Saratoga Geysers Natural Carbonic Gas Company.

No one was injured, and the damage consisted in the breakage of some plate glass windows in the vicinity, and slight injury to a cab horse.

Russia.

An explosion of ether occurred at Brest Litovsk, in the Russian province of Grodno, on the 11th November, at a chemist's shop, killing 20 persons, destroying the building and seriously damaging several houses in the vicinity. The accident was stated to have been due to the carelessness of the workpeople.

Accident with xylonite.

A fire occurred on the premises of the British Xylonite Company's works, Homerton, on 29th December, by which one man unfortunately lost his life.

The British Xylonite Company, Limited, carry on the manufacture of the substance known as xylonite, or (as it was originally called) celluloid, at their works in Suffolk. The actual manufacture of the raw material, however, is not carried on at Homerton.

Xylonite is formed from tissue paper, which is treated with nitric and sulphuric acid and converted into a pulp.

After being mixed with camphor and spirits of wine it is worked into a dough, pressed into blocks, cut into sheets, and certain pigments are added in its manufacture.

These sheets are prepared with methylated spirits and cemented in the press.

A number of articles are made, or are capable of being made, from it, such as knife-handles, combs, piano keys, billiard balls, hair pins, paper-knives, &c.

The material arrives at the Homerton works in the form of sheets.

At the time of the accident there were two sheets of xylonite in the press, being cemented together.

The press is a steam-jacketted iron press. The two plates are steam-heated at boiler pressure. The sheets of xylonite are put into metal frames on the bottom plate.

The press room is situated on the ground floor, and it is provided with two doors.

There was a naked gas jet within 2 or 3 feet of the press, and in a line between the two doors, and this was alight at the time.

It was stated that, besides the sheets in the press, there were about 4 or 5 cwt. of similar sheets already pressed in the room.

The man in charge of the press was in the dynamo-room adjoining, and was conversing with the deceased, when a hissing noise, followed by a dull explosion, was heard, and instantly the press room was in flames.

The deceased, who was a member of the Company's fire brigade, had apparently gone into the room with the object of getting the fire hose, and had doubtless been overcome by the fumes. The press man escaped unhurt.

The xylonite under operation at the time of the fire required to be heated to above 400° F. before it yielded inflammable vapour; the heat of the press was stated to have been about 210° F.

An examination of the press after the accident revealed the fact that the leather collar on the piston-rod had become defective, thus allowing the lower plate of the press to fall about 3 inches and expose the surface of the xylonite, a rapid formation of the spirit vapour was generated between the hot sheet of xylonite and the top hot plate of the press, and this uniting with the air an explosive mixture was formed.

The doors were open on either side of the room, a strong current of air would carry the vapour out of the press to the gas jet. The result would be the dull explosion; the flame from which would travel back to the press, setting fire to the sheet of xylonite, and communicating with the remainder of the material in the room.

The explosion blew out the window opposite the press, frame and all; the windows of the dynamo room, however, were not broken. It was quite obvious that there was no real explosion, but a burning of the material under confinement. The fire extended to the room overhead, through the band shaft, burning the benches, window-frames, and frames of ventilator, and broke a window, and burnt what xylonite there was in the room, but the workpeople escaped uninjured.

The coroner's jury returned a verdict of accidental death, and they added a rider to the effect that the manufacture and storage of such inflammable material as xylonite should be subject to regulation and supervision, with a view to securing the protection of the workpeople and the public, and the prevention of exposed lights.

The accident is interesting as bearing upon the question, which has more than once come under our consideration, and which will be found discussed in our Annual Reports,* viz., whether substances which under the names of celluloid, parksine, xylonite, &c. should be treated as properly falling within the restrictive regulations of the Explosives Act.

We have hitherto held (after full and careful consideration) that sufficient grounds did not exist, in the interests of public safety, for attempting to assign a construction to the Act which would bring such substances under its controlling provisions, when

* *See* Annual Reports for 1879, page 37; 1881, page 55; 1882, page 9; and 1892, pages 19 and 51.

they are being prepared solely with a view to photographic purposes, or to the manufacture of inexplosive articles, such as combs, billiard balls, &c.

The accident now under notice offers no sufficient reasons for deviating from the opinions which we have previously expressed, and we do not think that the material is in any way prejudiced in consequence thereof.

But as ignitions in the press are not impossible, and are known to have several times occurred, and as these may be attended with inconvenient and even serious incendiary results, we consider that the process of manufacture should be carried to a place better suited and adapted for localizing the effects of such accidents.

We believe that the Company have since undertaken to remove all the dangerous part of their work from London.

Suicides.

Suicides.

Five cases of suicide (four at home and one abroad) by means of explosives came under our notice during the year, this being an increase of two on the preceding year.

Central Street, St. Luke's, London.

A woman, aged 38, of Central Street, St. Luke's, purchased a half pennyworth of gunpowder, which she placed in her mouth, and set it on fire; she died the next morning from the injuries which she sustained.

Walsall.

A locksmith, at Walsall, placed a quantity of gunpowder in a vice box in his father's workshop, and, having seated himself in a chair, laid his head close to the box and turned the vice round and round until an explosion resulted. His head was blown into fragments, and the window of the workshop forced out of its frame. It appears that he had been in bad health for some time, and bad been suffering from delusions.

Nailsea.

A young miner at Nailsea, who appears to have lived unhappily with his wife, in her presence placed a dynamite cartridge in his mouth, calmly lighted a 30 seconds fuze and walked into the back yard. A terrific explosion followed, and the man's head was blown to pieces.

Devonport.

A plumber, aged 28, fixed a piece of gas-pipe in a vice, plugged one end of it, and drilled a touch-hole in the barrel, and having charged his improvised cannon with gunpowder, he inserted a torpedo-shaped piece of iron therein; he then placed himself in front of the weapon and fired it, and the iron entered into his body and killed him.

Foreign suicide.

A suicide by dynamite in the Department of the Aveyron was reported in the newspapers. From the account, it appears that the man had lately left his wife, and proceeding to a field placed a dynamite cartridge in his mouth and set fire to it.

His skull was blown to pieces, and there were marks of a burn on his right hand.

Scares, Hoaxes, and False Alarms.

There have been, as usual, a number of cases of scares, hoaxes, and false alarms, but none of them call for more than a brief notice.

City of London.

Thus, in January a startling rumour obtained in the City of London to the effect than an infernal machine had been discovered at the Royal Exchange, which proved to be a false alarm.

Regent Street.

In February a slight explosive report was noticed in Regent Street, which it appears was caused by the wheel of a cab passing over some composition in the roadway, probably of a similar description to that used for pipe lighters.

Blackheath.

In March a suspicious-looking package was discovered at Blackheath. This, on examination, proved to be a hoax.

Donegal.

In June a portion of an "infernal machine" was picked up in Donegal. An examination revealed the fact that it contained no explosive.

Liverpool.

In June a "brown powder" was brought into Liverpool; this turned out to be an irregular importation of "rack-a-rock."

House of Commons.

In August Mr. William Johnston, M.P., was made the recipient of a suspicious parcel, which, on examination, was found to be a filthy and silly hoax.

Farringdon Street, E.C. In October some electric detonators and electric detonator fuzes were discovered at Turnmill Street, Farringdon Street, E.C. No suspicion, however, attached to anyone. The explosive was destroyed.

Isle of Ely. In the same month (October) a suspicious parcel was discovered at the Isle of Ely, which, on examination, proved to be quite harmless in character.

Hampstead. A sensational report was circulated in the London papers on the evening of 5th December, to the effect that an important discovery of dynamite and supposed infernal machines had been made in the morning by a sheriffs' officer while executing a distraint on the goods of a foreigner, residing at 24, Parliament Hill Road, Hampstead; and it was subsequently ascertained that the three so-called "infernal machines" or "bombs" were merely articles known in the gun trade as fuze bases.

The foreigner was a gentleman named Snyder, the Managing Director of the Snyder Dynamite Projectile Company, Limited, and a patentee of explosives, who had come to England with a view to selling his invention.

Westminster Bridge. A further sensational announcement appeared in the London papers of 4th November, to the effect that a bomb was found under Westminster Bridge, about 50 yards from the terrace of the House of Commons, and attaching great significance to the incident.

The circumstances which gave rise to the rumour were the following:—A waterman who was looking for some tools which had dropped from the workmen engaged on the bridge, found a shell on the concrete under the third arch of the bridge, from the Middlesex side. The shell was one that was found on a battlefield, and being loaded and fuzed, the possessor of it, wishing no doubt to get rid of it, dropped it, as he thought, into the river; it lodged, however, as stated, on the concrete, where it was picked up.

Bermondsey. A suspicious-looking package was found at the Great Bear Beverage Company's premises, in Loftie Street, Bermondsey, which turned out, on examination, to have been a hoax.

OUTRAGES AND MALICIOUS ATTEMPTS.

Home.

Monmouth. On 19th April, a tin can containing about 10½ lbs. of gunpowder, with an arrangement for exploding it, was discovered on the line on the Newport entrance to the Gair tunnel. No clue to the author of the attempted outrage has been obtained.

Four Courts, Dublin. On 6th May, about 10.40 p.m., an infernal machine exploded at a block of buildings containing the law courts, and known as the Four Courts, Dublin, situated on the north bank of the River Liffey, at Inns Quay.

The circumstances of the case were simple. Some person or persons passing the railings which divide a courtyard from the quay, flung the infernal machine through the railings into an area about 9 feet 6 inches wide and about 8 feet deep, below the level of the courtyard.

An explosion followed, happily unattended with loss of life or personal injury, but causing considerable damage to the windows facing on to the courtyard, of which 349 panes of glass were broken.

The case was investigated by one of us, and when considered by the light of the previous outrage which occurred in the Chief Secretary's Office, Dublin Castle, on 31st December 1891, and also the outrage at Exchange Court on the Christmas Eve of 1892 (when Detective Sinnott was killed), no other conclusion could be arrived at than the explosion was, beyond all doubt, of a malicious character.

Broadstairs, Kent. A serious outrage took place at Broadstairs on 22nd July. It appears that a Mr. Richards, who was staying at Broadstairs with his wife and two children, received a small parcel wrapped up in brown paper, which arrived by that morning's post. But having some suspicion as to the nature of its contents, he did not examine it then, but took it with him to a house which was being built for him near the railway station. He showed it to a Mr. F. Martin, a contractor, who was superintending the erection of the house, and mentioned to him the fact of his having received it that morning from London. He then, standing in the roadway outside the house, proceeded to cut the string with which the parcel was tied with his penknife, and on his doing so the contents exploded. He was very seriously injured, and died at 4 o'clock the next morning. Mr. Martin, who was standing near him, was also

injured, but not seriously. Mrs. Richards, the two children, and a workman who were standing near him escaped without injury.

From inquiries made by one of us, it appeared that the parcel consisted of a tin canister about 4 inches by 3 inches by 1 inch, containing about half a pound of powder. Within it there must have been some means of igniting the gunpowder, so arranged as to be set in action by the cutting of the string. As no trace of it, however, could be found among the débris, which was carefully examined, the ignition was possibly effected by a "chemical" device.

The coroner's jury brought in a verdict of wilful murder against some person unknown.

Several men were in the "Tipton Tavern" Inn, New Road, Great Bridge, and among them was a man named Thomas Madden, who appears to have had some detonators and fuze in his possession. He lit the fuze and threw the detonator on the floor; it exploded with a loud noise, and three of the men were seriously injured. (*See also* Accident 71, when a somewhat similar occurrence, though not, as is believed, maliciously caused, took place.) Great Bridge, Staffordshire.

The man who caused the explosion was arrested and sentenced to six months' hard labour.

The firm of Messrs. Peter and Samuel Wood, at the Pump House Brick Works, Greets Green, at which Madden was employed, were summoned and prosecuted for infringing the Explosives Act, and were fined 10*l.* 13*s.* 6*d.*, including costs.

On the 27th August an outrage was reported as having been committed at Chorley. A cartridge, probably of tonite, with a lighted fuze was thrown into the garden of a farmhouse at Euxton, occupied by a man named John Driver, resulting in the breaking of 12 panes of glass. Several articles in the kitchen were broken by falling. Four men were shortly afterwards apprehended and were found to be under the influence of drink. Chorley, Lancashire.

On one of them was found two tonite cartridges, three detonators, and a quantity of fuze, which had been obtained at Mr. Brownley's brick works, where one of them had been employed. One of the men admitted lighting and another admitted throwing a tonite cartridge. The magistrates finding that there was an entire absence of malicious intent reduced the charge to wilful damage to property, and fined each of them 50*s.* and costs.

The house of Thomas Jones, a colliery fireman, residing in Chancery Lane, Parr, near St. Helens, was "wrecked" on 17th September by an explosion, the work of some unknown person. The explosive used was roburite. The reason commonly assigned for the outrage was that Jones had returned to work at Havannah Colliery. He and his wife and child escaped unhurt, notwithstanding the extent of the damage. Parr, near St. Helens.

During the delivery of a special sermon in St. George's Roman Catholic Cathedral, Southwark, on Sunday night, 1st October, an alarming explosion took place, which caused considerable excitement amongst a crowded congregation. Some miscreant had thrown an explosive (the nature of which did not transpire) through the western door when, alighting in the eastern aisle, it exploded. No damage was done, and no clue to the author of the outrage has been obtained. St. George's Cathedral, London.

A further outrage was perpetrated at St. Helens on Friday morning, the 20th October, at the house of Joseph Harrison, Broad Oak Road, Parr. Harrison was employed as fireman at the Ashton's Green Colliery, the scene of the previous Tuesday's rioting, but he ceased working on Monday. He had, it appeared, been threatened, and feared an outrage. He and his wife and six children remained downstairs until one o'clock in the morning when, seeing some police constables about, he retired. At three o'clock the whole district was startled by a tremendous report, and the terrified neighbours, rushing to the spot, found that the front of Harrison's house was demolished. There was evidence, it was stated, that roburite had been fired on the window-sill. All the windows for a considerable distance around were smashed. Broad Oak Road, Parr.

Harrison and his family had extremely narrow escapes.

Some explosive placed on the window-sill of a house occupied by a gamekeeper was fired on the night of the 27th October, breaking the window panes and damaging the framework. The outrage appears to have been perpetrated by some person having a spite against the man. No one was injured, although a child was sleeping in the room to which the explosive was directed. Ovingham, Northumberland.

Aldborough Barracks, Dublin.

On 26th November, as one of the soldiers stationed at the Aldborough Barracks, Dublin, was walking in the barrack yard, he observed lying on the ground—close to the corner of the wall that forms the Gloucester Street boundary—a small object wrapped in white paper, and which, on subsequent examination, turned out to be an infernal machine on a small scale.

It consisted of a tin box, with a piece of fuze about 11 inches long, and having a detonator attached. It contained dynamite of a home-made description, and although roughly and unskilfully manipulated, it appeared to be of a destructive character. The total weight of the machine amounted to about 2½ lbs., and the fuze had the appearance of having been lit.

Considering all the circumstances, it was undoubtedly intended for the production of a malicious explosion, and forms an additional item to the series of outrages and attempted outrages, which have obtained in Dublin in recent times.

Tyrone Place, Dublin.

On the 27th November a detonation was heard at about one o'clock in the morning, at Tyrone Place, Dublin. On the police proceeding to the spot, they found a burning fuze, which they extinguished. Later in the day a man was arrested and charged with having in his possession, between one and two o'clock that morning, in Henry Street, six detonators, and failing to give a satisfactory account of the same—whilst admitting that he had been in Tyrone Place that morning—he was remanded.

On the same night a man named Patrick Reed, well known to the police as a member of a society which has given them much trouble, was observed having an angry discussion with two other men in Cardiff Lane; two shots were heard, and Reed was subsequently found lying in the road having, it is supposed, been shot dead by the other men, who decamped.

Dalziel, Lanarkshire.

An explosion of a malicious character took place outside the dwelling-house of a gasman in Cowies Square, Craigneuk, Dalziel, Lanarkshire, about 12.45 a.m. on Sunday, 10th December, which resulted in the breaking of about 10 panes of glass in the neighbourhood.

It was evident from the peculiar description of fracture, in "striated cracks," that a high explosive such as dynamite, &c. had been employed; it was equally clear that the amount of explosive employed was very small, as the damage inflicted might have been caused by the explosion even of a single cartridge.

Foreign Outrages.

Foreign outrages.

The year 1893, like its predecessor, has been remarkable for the extraordinary number and grave character of the outrages which have been perpetrated, or attempted abroad, in futherance of political, social, industrial, or personal objects. This class of outrages has indeed surpassed all former experience, and among the more noticeable of the occurrences may be especially signalized the outrages in the Chamber of Deputies, Paris, and in the Liceo Theatre, Barcelona. We can only repeat that "There is only one gratifying consideration in connexion with the long and dreary "list of these outrages, and that is, that the frequency and cosmopolitan character "of crimes of this sort probably bring us so much nearer to the time when an "international agreement will be arrived at whereby criminals of this class will, like "pirates, be treated as enemies of the human race, and pursued with relentless "rigour from country to country, and debarred from shelter or sympathy in any "part of the civilised world, and this without reference to whether the actuating "motive was political, industrial, or other. Indeed, it is difficult to understand how "any motive can be deemed to sanctify or palliate so horrible and dastardly a form "of offence, one of the most deplorable features of which, as we have before remarked, "is the callous indifference to whether the consequences fall on persons wholly innocent "of any participation in, and unconnected with, the particular matter or cause against "which the crime is directed."*

A step in the right direction has been taken in France, for, as we have observed with satisfaction, one result of the explosion in the Chamber of Deputies, has been to cause a considerable strengthening of the French law, as it bears upon the actual or suggested commission of acts of this character, while Spain has suspended in Barcelona, by Article XVII. of the Constitution, the guarantees relating to the liberty of subjects, thus empowering the authorities to arrest suspects without going through the prescribed forms of law.

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* Annual Report, 1892, p. 54.

America.

Two "sticks" of dynamite were found on 30th January, on the track of the Union Pacific Railway, near Colfax, Washington State. It was presumed that the explosive was put on the line with the object of wrecking a train. Colfax.

Dynamite contained in iron cylinders and hidden under some planks in the hold of the ship "Cyrus Wakefield" was discovered while the vessel was lying at her berth on 17th March. New York.

When the "bombs" were discovered the captain resigned, and two other captains were unsuccessfully applied to; and the one who ultimately accepted the post, on becoming aware of the circumstances, expressed his regret at having signed articles of agreement.

The vessel, a three-master of 2,700 tons, was bound for San Francisco, with a cargo of petroleum.

One of the stevedores who loaded the cargo, had, it was stated, referred to the vessel as a doomed ship, and that a million would not tempt him to ship in her.

On the arrival of the "Tauric" of the White Star Line, the captain reported the discovery of huge packages of crackers, found hidden among the bales of jute. The fireworks were close to the engine room, and this choice of their position was considered to have indicated that it was selected for a purpose. New York.

A number of seamen refused to ship in the vessel, and it was hinted that the fate she had escaped may have overtaken the "Naronic," a sister ship; upon this point, however, we have received no information.

The agent of the Company believes that the fireworks were smuggled on board the "Tauric" at Liverpool, but inquiry confirmed the theory that the explosive materials were brought on board in New York Harbour.

A band of robbers stopped an express train on the Missouri Pacific Railroad, 30 miles west of St. Louis, on the 24th May, and after breaking open the express car with *dynamite*, compelled the messenger in charge to open the safe and hand over its contents, which are believed to have amounted to about $4,000. The Governor and Treasurer of the State of Missouri were travelling in the train. St. Louis.

A dynamite bomb was, on the night of the 5th June, placed under the door of the building at Cattlettsburg, containing the offices of "The Hustler" a weekly newspaper. In the explosion that followed, the entire structure was wrecked. The explosion caused great excitement among the people. "The Hustler" was mainly instrumental in obtaining the passage of the Local Option Law. Kentucky.

On 12th June, a hackney coach wheel passed over a tin box containing dynamite; a formidable explosion was stated to have occurred, by which the driver was killed on the spot, the carriage wrecked, and one of the horses was badly injured and had to be shot. New York.

On 17th August, a desperate attempt was made to wreck a train on the Rio Grande and Southern Railway, near Red Rock. Two "sticks" of giant powder were placed on the rails, and upon the engine striking them, an explosion occurred. The engine driver was thrown from his seat, and the engine and a pony truck were greatly damaged, but no one was injured. No clue was obtained as to the perpetrators of the act. Denver (Colorado.)

According to an account in the newspapers, it appeared that the feud, which it was stated existed between the Coast Seamen's Union and the shipmasters and non-union men, culminated in the former resorting to the use of dynamite. An infernal machine was exploded on the 25th September in front of Curtin's lodging house, the house being occupied principally by seafaring men who were non-unionists. San Francisco.

The dynamite was in a valise, made of American oil-cloth, and the whole was wrapped in grey blankets and was placed on the doorstep. Curtin, junior, who was returning home from the theatre, with some young companions, noticed it and picked it up to have a look at it, but having a suspicion that it contained dynamite he dropped it again. Shortly afterwards, a terrific explosion occurred, the front of the premises was literally torn out, and the whole structure so badly wrecked that it will have to be rebuilt. Two of the young men who were standing near the spot were instantly killed, and two others succumbed after reaching the hospital.

Curtin, junior, and another man (Bernard) were seriously injured, the latter, it was believed, fatally.

One of the newspapers commenting on the outrage, stated that "the devilish malignity "which inspired this hideous deed was utterly indifferent as to how many or whose "lives were sacrificed. It was intended to wipe out Curtin and his business, without "regard to the calamities that might be inflicted. A more cowardly, merciless, and "cold-blooded scheme of murder was never planned, nor was one ever executed with "more quiet ferocity.

"It was intended to destroy John Curtin's house, destroy John Curtin, destroy "anything or anybody else, it mattered not who, so that the establishment was broken "up.

"The sacredness of the helpless women and children, the danger to those ignorant "and unconnected with the trouble, aroused no spark of compunction, moved no "humane impulse in the savages who wrought their work of destruction and slaughter."

Numerous houses in the vicinity suffered considerably, and there were many narrow escapes.

Last spring, the cylinder heads of the "Ethel and Marion" were blown off with a giant powder cartridge. Later, the after cabin of the "Bawnmore" at Porto Rico was smashed by an explosion, and less than a month previously, a bomb exploded in the hold of the "Barracouta." All of these ships had trouble with the union.

An ingenious arrangement, by which an open rat trap was connected with a revolver, was also discovered in the hold of the "Bawnmore," together with 12 lbs. of dynamite, which it was calculated would cause an explosion, and blow up the vessel on the way from San Francisco to Nanaima.

Pittsburg. On the 25th September, Mrs. Augustus Resse was killed, and her husband fatally injured by two anarchists named Marston and Brice, who had been selected by the council of the anarchists to carry out the penalty of death against Resse and his wife, in consequence of the latter having become acquainted with some of the most important secrets of the organization. Marston and Brice were arrested, as they were about to leave for Canada, with the intention of blowing up various Government buildings there.

Canada.

Montreal. On the 19th November, three young men belonging, it was stated, to the French section in Montreal, were arrested on their way to the Nelson Memorial in that city. They were found to have dynamite and fuze in their possession, with the intention, it is stated, of blowing up the monument.

Australia.

Australia. Several dynamite cartridges were stated to have been found on board coasting steamers carrying non-union crews, and one cartridge was exploded on board the S.S. "Aramac," from Sydney, while nearing the port of Brisbane.

Austria.

Vienna. A number of important arrests of anarchists have taken place at Vienna, being accompanied by the discovery of a large quantity of explosives, bombs, &c. All the bombs are stated to have been made according to the instructions given by the well-known anarchist Most.

Belgium.

Altona Station. A railway official found a dynamite bomb between the rails at the Altona Station. He brought it to the stationmaster, but before it could be examined it exploded and inflicted serious injuries on both of them.

Liege. A dynamite bomb was exploded on the night of the 26th July, in the residence of the manager of a factory at Ensiral. The premises were much damaged. A man was arrested on suspicion of having committed the outrage, but no further details have been published.

France.

Paris. On 10th April, 1893, a blacksmith found a brass tube lying on the window sill. After trying to open it with his fingers without success, he took the tube with a pair of pincers, placed it on the anvil, and struck it with a hammer. The explosion

which followed was so violent, that not only were the blacksmith's hands horribly mutilated, but the shutters of the workshop were torn from their hinges. The windows of the neighbouring house were also shattered.

Two men who had threatened the blacksmith, saying they would blow up his workshop were arrested, but no further particulars have been received.

On 17th May the police seized three explosive bombs ready for use, others in a half finished state ; and they also discovered acids, powder, &c.

Three finished bombs were discovered in a basket which had been buried in a garden at some depth. They were made out of old tin preserved vegetable canisters, 10 centimetres thick and 7 centimetres in diameter. They were examined by the Director of the Municipal Laboratory and were found to be most dangerous to handle, the corks fitting the acid tubes badly. Five anarchists were arrested.

Lens.

A dynamite cartridge was exploded on 19th October in front of a house occupied by a miner who had resumed work. Some damage was done to the building, but no one was injured. Four other cartridges with the fuzes burnt out were found at different points. Considerable agitation was stated to have prevailed at night time through the Lens colliery district.

Marseilles.

An attempt was made to blow up the residence of the Commander of the 15th Army Corps on the night of the 15th November. The house is surrounded by a wall in which sentry boxes are built, and there was every evidence that the explosive was placed in one of these situated close to a room which is used by the General's orderlies during the day. A considerable breach was made in the wall, and débris was hurled into the guard-room, causing much havoc there. No one, however, was injured. The explosive had evidently been contained in a tin box about 1 foot in height, as a lid of a box of this description was found. One man (an Italian) was arrested. The effects of the explosion were widely felt, and a considerable amount of damage was caused. A second bomb was discovered in the passages of the General's house.

Chamber of Deputies, Paris.

On the 9th December, during the sitting of the Chamber of Deputies, at the Palais Bourbon, and just as M. Mirman had finished his speech on a question arising out of a contested election, in a house composed of 450 deputies, a well-filled double line of galleries, and about 100 reporters—there shot a dull red gleam just above the heads of the Conservative members, and immediately followed, like the report of two or three pistols, the sound of an explosion.

A bomb had been thrown from one of the galleries, and in its fall it came in contact with the parapet or balustrade of the gallery, and exploded in mid-air ; accordingly it did not wreak anything like the ruin that would have ensued had it fallen, as it was stated it was intended, among the mass of Deputies below. As it was, however, the chamber was described as being filled in an instant with smoke, dust, and blood. Men and women lay senseless and bleeding in the galleries, and of the members themselves many were struck by the heavy large headed nails with which the bomb was charged. The place had become a hospital—one woman had her breast almost torn away, another had her knee cap fractured, while all about were men and women in the hands of surgeons who were busily engaged in extracting bits of iron, nails, &c. from the faces and hands of those injured.

The number of persons injured was stated to have been about 80 (10 seriously, although none dangerously) ; the majority of the sufferers had occupied the second and third boxes from the end of the galleries on the right, next to them came the Deputies who had been sitting just near the bomb, some 30 of whom were struck.

The bomb, it appears from the description given by the anarchist (Vaillant) who threw it, consisted of a small iron saucepan, with a sulphuric acid igniting arrangement.

Vaillant confessed to, and even gloried in, the crime, stating that he waited more than an hour for a favourable opportunity of throwing the machine, and then thinking it had at last arrived, he rose and hurled it into the body of the house. At that moment a woman sitting in front of him, resenting his leaning over her, pushed him back, and thus prevented him throwing it exactly where he intended, thus accounting for its striking the balustrade in its descent.

Vaillant was afterwards executed.

Germany.

Volksmarkseller. Harz District.

A terrible explosion, which it has been ascertained was deliberately caused by a miner, occurred on 16th March in an iron mine at Volksmarkseller, in the Harz district.

The miner ignited no less than 10 lbs. of dynamite. The engine house at the top of the shaft was demolished, and seven men, including the miner himself, were hurled into the air. The miner who was about 50 years of age, went to work somewhat earlier than usual, and left a letter at home in which he stated that he would not return.

Berlin.

Amongst the correspondence which reached the Chancellor on Sunday, 24th November, was a small box, accompanied by a letter bearing the Orleans postmark of the previous day.

When the aide-de-camp on duty, after reading the letter, proceeded to handle the package and began to undo the lid, a few black grains fell out which he at once recognized as gunpowder. The box on examination by the police was found to contain an explosive substance which a peculiar contrivance was intended to detonate on the lid being opened.

The machine is described as closely resembling one that exploded last summer at the police-station at Spandau.

The wooden box containing the infernal machine was 2 inches in height by 6 inches in length, and the hammer which was intended to strike the detonator was held back by india-rubber bands.

The box was so constructed that, as stated, when the lid was completely opened, the hammer would be released. Beneath the detonator was a dynamite cartridge.

It was stated that a similar package accompanied by a letter of the same tenour and date was addressed to the Emperor, and was delivered to the Civil Cabinet. In this case, also, a fortunate accident raised timely suspicions and averted an explosion.

Italy.

Rome.

During the year a very large number of outrages and attempts took place in various parts of Rome.

The infernal machines employed generally consisted of a crude kind of hand grenade filled with gunpowder, and lit by means of a piece of ordinary fuze. The effect of these bombs appears, in most instances, to have been of a comparatively harmless character, doing very little damage to buildings, and fortunately unattended with loss of life.

The only instances, which have come under our notice, of personal injury as having been caused by these outrages, were, curiously enough, two cases in which the anarchists themselves were blown up.

Via San Claudia and Via Borgognona.

On the 22nd January, two bomb explosions followed one another at short intervals. One occurred at the entrance to a house in the Via San Claudia, while the other took place in the Via Borgognona beneath a window of the Hotel d'Angleterre.

Serious damage was caused at the hotel. The windows were smashed, and the room, outside of which the bomb was placed, was wrecked, the furniture being broken.

The damage in the Via San Claudia was not so serious, being mostly confined to the breaking of the windows. Nobody was injured. The outrages are believed to be the acts of private vengeance directed against the proprietor of the Hotel d'Angletérre who is also the owner of the house in the Via San Claudia.

Via Fienaroli.

On the 18th February, a "smoker" passing through the Via Fienaroli, threw a half burnt match on a heap of rubbish, whereupon several detonations took place, and four persons who happened to be passing by were injured. It appeared that some explosives were concealed in the dust. The injured men belonged to a secret society for the manufacture of bombs. Three of them were arrested, together with several other persons, on suspicion of having caused the outrage.

Antici Mattei Palace.

On 17th March a large bomb was exploded on the staircase of the Antici Mattei Palace. Three of the steps were blown to pieces, and the windows of the adjoining houses were shattered. The building was inhabited by three families, including that of the United States Minister, Mr. W. Potter. The act appears to have been prompted by motives of personal vengeance against the proprietor of the Palace, as last year it appears that a similar outrage occurred in the same building. The authors of the outrage were not discovered.

Altieri Palace.

On the same day a bomb encased with plaster of Paris and with a lighted fuze attached to it, was found by a boy on the steps of the Altieri Palace, where the Club

of the Papal Guardia Nobili is situated, and where the Court of Appeal holds its sittings. The boy extinguished the fuze by treading upon it, and he summoned some policeman to the scene.

On the evening of the 27th August a bomb was exploded outside the same building. The damage done to property was insignificant, but one person, however, was seriously injured, necessitating the amputation of one of his legs. It was reported that he was the author of the outrage, but he was understood to have asserted that he was only passing at the time.

Marignoni Palace.

On the 20th March a bomb of large size was exploded in the entrance hall of the Marignoni Palace. Fortunately no one was injured, and the damage was confined to the breaking of some windows.

Ministry of Finance.

On the same date (20th March) a workman was arrested just as he was about to deposit a bomb filled with powder outside the Ministry of Finance.

The multiplication of these outrages (which up to March averaged eight per month, and of which only those herein described have come under our notice), caused much uneasiness in Rome, not only from their frequency, but also from the fact of the impunity with which they were committed.

Pisa.

Quite a panic was caused at Pisa on 11th October, owing to the explosion of a bomb in the vicinity of the Florentine Gate there. Many windows were broken, but no one was injured.

Spain.

Madrid.

At a late hour on the night of the 20th June an explosion was heard in Serrano Street, opposite the stables of the English Tramway Company, and close to the residence of Señor Canovas del Castillo. The police authorities are reported to have stated that the explosion was caused by a petard supposed to have contained nitro-glycerine, contained in a bottle enveloped in wire, which exploded in the hands of two men just as they had lighted the fuze and were going to place the petard against a wall near the library of Señor Canovas. One of the men was killed on the spot. His accomplice, who was badly injured, attempted to escape, but was captured. In the possession of the Anarchist who was fatally injured were found three petards. The explosion was so violent that it literally blew away one of his arms, smashed his head, and inflicted various injuries on him. No further damage occurred.

The police suppose that these Anarchists probably had something to do with the petard explosions in the gardens near the palace, which took place the week previously.

Calle San Clemente, Seville.

A dynamite bomb was exploded in the Calle San Clemente on 25th June. Much damage was done to property, but fortunately nobody was injured. The police profess to have a clue to the perpetrators of the outrage.

Royal Palace, Seville.

On 28th June a large dynamite bomb was stated to have been found in the garden of the Royal Palace at Seville, but, fortunately, the fuze was extinguished in time to prevent an explosion.

It is positively stated that the Anarchists had planned the destruction of the building in which the Cortes hold their sittings, and that extensive measures of precaution had been taken by the police, and that numerous Anarchists have been arrested.

Barcelona.

A most daring outrage was committed during a military review which was held at Barcelona on 24th September. Two petards were thrown into the midst of a group of staff officers, and exploded under the horse of Marshal Martinez Campos. The animal's legs were shattered, and the Marshal was injured in the thigh. He fell heavily to the ground, and in so doing injured his left shoulder. The explosion also wounded General Castelloi, Chief of the Staff, and General Perez Clemente; killed a civil guard, an aide-de-camp, and several policemen. Altogether it appears that the number of officers and men injured amounted to 13, whilst the number of persons who were trampled upon and injured in the panic has not been ascertained. A young girl who was also wounded had a leg amputated.

Both bombs were large ones of the Orsini type, and it is supposed that they were thrown by the Anarchist Pallas.

Pallas was arrested, tried, and sentenced to be shot. He was executed on 6th October.

Barcelona. At the Liceo Theatre.

But the most serious of all the outrages was that which was committed at the Liceo Theatre, Barcelona, on 7th November. The theatre was filled with a large and distinguished audience who had assembled (on the first night of the Opera Season) to hear the popular opera of "William Tell."

While the performance was going on a bomb* was hurled from one of the galleries into the midst of the stalls in the pit, spreading death and destruction in all directions. The whole audience rose to their feet in terror, scarcely knowing what had happened. The theatre rang with shrieks of fear, and cries of pain and terror. For a moment the house was filled with blinding smoke and dust, and almost before the people knew what they were doing a mad rush for the doors took place, and many were crushed and injured.

The scene, it was stated, was one which would never be forgotten. The stalls presented a terrible sight. The part where the bomb exploded was a mass of wreckage, amid which lay a number of dead bodies, some of them horribly mangled.

Twelve persons were killed on the spot, and ten others were fatally injured; three others succumbed to the effects of terror, anxiety, or profound emotion.

The number of persons who were injured is stated to have been 29 (11 seriously), whilst the number of those who were slightly injured was considered to have been much greater.

The bomb was evidently thrown from the gallery in the fifth stage of the theatre, and it struck the woodwork in one of the stalls in the pit.

Another bomb which was found later on, near the site of the catastrophe, was considered by some to have been thrown also, from the gallery, and at about the same time as the other one, and appears to have fallen on the lap of a lady who was killed, having been found unexploded at her feet.

The bombs are believed to be similar; they are of the Orsini type, spherical in shape, and about $3\frac{1}{2}$ inches in diameter.

They are of cast iron, about $\frac{1}{4}$ inch thick, and have an opening through which they are loaded, generally with dynamite.

They have 30 equi-distant perforations on their surface to which nipples are attached in such a manner that the bomb settles on one or more of them on being thrown, and on these nipples fulminating caps are placed when it is required to explode them.

A certain amount of force it appears is necessary for their explosion; as from some trials which had been made, it was found that they may be dropped ineffectively from a height of from 3 to 4 feet.

An Italian Anarchist who was taken into custody on suspicion immediately after the occurrence, and in whose possession a handkerchief was found showing evident marks, it is asserted, of the nipples attached to these bombs, and who unsatisfactorily explained his presence in the pit by stating that he had been requested by some gentleman he did not know to take a shawl he gave him to a lady he did not know either, gave rise to the opinion that, having a bomb in his possession which he was anxious to dispose of, and which he was bound by his confederates to throw, being either unwilling or unable to throw it without risk, left it at the spot where it was found after the occurrence.

The Ministerial Council subsequently dealt at great length with the question of the outrage, and the Official Gazette of 10th November published a Royal Decree suspending within the province of Barcelona, by virtue of Article XVII. of the Constitution, the guarantees relating to the liberty of subjects comprised in Articles IV., V., VI., and IX.

The effect of this decree will be that the authorities can arrest suspected persons without going through the prescribed forms of law. The decree also gives power to police agents to enter the domiciles and examine the documents and effects of suspects without previous warning and without warrant.

Circular.

The following circular which was addressed to the judges throughout Spain, appeared in the "Madrid Gazette" of 18th November 1893:—

"Article 582 of the Penal Code punishes as delinquents those persons who directly provoke the perpetration of any crime by means of newspaper articles, drawings, and other mediums of publicity, and paragraph 4 of Article 584 punishes as guilty parties those persons who employ like methods for the purpose of eulogizing actions qualified as crimes.

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* Some accounts stated that two more bombs (making four in all) were found among the rubbish, and that had all four exploded, the theatre would probably have been destroyed.

"The fanatical followers of doctrines which in this and other countries are productive of criminal resolutions by collective associations to uproot the established social order by incendiarism and terrorism are boldly proclaiming in the press and at public meetings their nefarious designs, and their intention to exterminate everything which exists under the protection of the laws of the universe. Both in the press and in their speeches they refer in eulogistic terms to these crimes, and publicly extol their authors, at the same time encouraging the provocation of further criminal outrages. Mankind is alarmed at the cold indifference with which these hardened wretches sow destruction indiscriminately among their innocent victims. Such boasting and provocation, impudently cast in the face of the upholders of social order, call for a vigorous application of the laws in defence of humanity, which must be strictly enforced with unhesitating energy by those charged with the dispensation of justice.

"It is the duty of the fiscal authorities, assisted, as is to be hoped, by the governing authorities, to exert the greatest vigilance and to obviate any forgetfulness or carelessness.

"I trust that your functionaries will prove faithful, without vacillation, and acting when necessary with energy in the performance of their duties, and that you and your immediate assistants will always be prepared to initiate and intervene in criminal prosecutions; that you will further exercise your authority by means of the instructions empowering municipal fiscal authorities to act in all matters within their sphere, with the assistance of their subordinates, so that when crimes declared punishable by the Penal Code are discovered, our Ministry may enforce that code immediately and inexorably.

"I have, &c.
"(Signed) MARTINEZ DEL CAMPO,
Madrid, 17th November 1893."

"To the Procurator Fiscal of—

Another bomb outrage was attempted at Barcelona on the night of the 14th November. As a number of troops were marching to the quay to embark for Melilla, large crowds gathered to cheer the soldiers. Just as the force was passing through the Plaza Real, a petard was discovered on one of the houses overlooking the square. One of the workmen who noticed the burning of the fuze, with great presence of mind at once rushed forward and extinguished it. An examination showed that the bomb was one of a most destructive kind. But for the promptness of the workman, another terrible disaster might have resulted. Barcelona.

On 23rd November a petard was exploded in the dwelling of the Secretary of the Agricultural Committee. The flagstones and pillars in the courtyard were blown into the air, the walls of the building were rent, and the windows were smashed, but fortunately no one was injured. Two arrests were made. Barcelona.

An attempt, presumably on the part of Anarchists, was reported in the newspapers from Villanueva y Geltru, in the province of Barcelona. A bomb was placed against the gate of the barracks, followed by an explosion, and the partial shattering of the building, fortunately without injury to the inmates. Villanuevay Geltru.

On the 18th November two large petards were exploded, one near the Hotel de Paris and the other near the Calle de la Paz. Several houses were damaged, but no one was injured. Much indignation was created among the inhabitants of the city. Valencia.

At Tarragona the police arrested two men with petards in their possession, one of the men being a native of Barcelona. Tarragona.

Switzerland.

In June a supposed dynamite bomb was discovered at the railway station, but on examination was found to contain no dangerous substance. Berne.

The inhabitants of the city were stated to have been rendered anxious by Anarchist threats to blow up public buildings. The Federal Palace, the Town Hall, and Foreign Legations have consequently had to be placed under military protection.

Petroleum Accidents.

Following the practice of former years, we will now notice the more important petroleum accidents, repeating what we have stated on former occasions, viz., that a list of such accidents and the particulars which we are able to give necessarily make no pretence to completeness.

Accidents in conveyance of mineral oil in bulk.

An accident to a mineral-oil tank-waggon, belonging to the Anglo-American Oil Company, occurred at Birmingham on the 21st January. It appears that one of the two horses became restive, and the driver was about turning the horses heads down hill to give them another start, when they bolted, and in the driver's efforts to avoid a collision with other vehicles pulled his horses sharply into a side street, and when turning the corner the weight, which is stated to have been "nearly 4 tons," being on the off hind wheel, wrenched it and caused the waggon to turn over on its side. Only a small quantity of oil escaped from the tank, but a few cans containing oil, carried on the side were damaged, and we understand that several gallons of oil escaped from these, and ran into a sewer near to the scene of the accident. In the course of inquiry into this matter it transpired that a somewhat similar occurrence had taken place on the 28th October 1892 near Birmingham, when a tank-waggon belonging to Messrs. Hill and Son, of Heath Town, Wolverhampton, containing Russian mineral oil was being driven along the Hagley Road, and the axle broke, resulting in the tank overturning. A considerable quantity of oil is said to have escaped on this occasion.

It is evident from these occurrences that it is of the first importance that tank-waggons used for this description of traffic should be—as the American Oil Company claim theirs are—specially constructed as regards strength.

23, Tower Street, Lambeth.

A fire, which resulted in the death of a woman and her two children, broke out on 26th January, on premises at 23, Tower Street, Lambeth. The occupier used the front portion on the ground floor as a small "general shop." He sold petroluum, which he stored in a barrel under the staircase. This barrel, which stood on end, had a defective bung, and the oil leaking out had saturated the floor and the litter thereon. He took a lighted candle to discover the source of the leakage, and dropping the candle a blaze was soon established; attempting to extinguish the flames with a pail of water only made matters worse by spreading the flames further (and he himself was somewhat burned in the attempt). A friend who was assisting him unfortunately capsised the barrel (which contained about 20 gallons), the flames cut off the egress of the inmates upstairs, some of whom, however, were rescued by the fire brigade.

The coroner's jury returned a verdict of accidental death, and added a rider unanimously agreeing that there ought to be supervision and control over the storage of petroleum oil in all shops of this class.

Nicholas Street, Hoxton. Oil shop.

A destructive fire broke out in an oil shop at Hoxton on 14th March, between 6 and 7 o'clock in the morning. When the firemen arrived they found the oil shop a mass of flames from end to end, and although two hydrants were promptly set to work, the premises were gutted. The origin of the outbreak was unknown.

99, North End, Croydon. Oil and colour shop.

On Sunday morning, the 30th April, a fire broke out at a large oil and colour shop, 99, North End Road, Croydon, the occupier being away from home at the time. Several police officers on the spot promptly succeeded in removing two barrels of paraffin. Soon afterwards a cask of petroleum, which was left in the cellar, burst, and the fumes caused the officers to effect a speedy retreat. One police-man, however, failed to effect his escape and was severely burnt, and succumbed to his injuries, while one of the other constables sustained an injury to his head and a severe shock to the system.

The coroner's jury returned a verdict of accidental death.

Paraffin oil stores of Messrs. Bell and Sons, Waterford.

On 24th July the oil stores of Messrs. Bell and Sons, Waterford, caught fire, and had it not been for the exertion of sailors from ships taking part in the naval manœuvres, a disastrous conflagration must have resulted. In a short time 200 barrels of oil had been removed. The remaining barrels, some 20 in number, caught fire. The premises destroyed and injured were not insured.

Oil shop 62, Fulham Palace Road, Hammer-smith.

On the 4th September at an oil shop at 62, Fulham Palace Road, Hammersmith, the occupier and four of his children were burnt to death through a fire which occurred on his premises, and which it is believed originated at the foot of the staircase, and was probably due to the ignition of some matches of a character which would ignite on falling to the ground.

All the petroleum oil (about 20 gallons) kept on the premises was stored in an iron tank in the kitchen, from which it passed through a leaden pipe to a tap at the foot of the staircase, the floor of which was saturated with grease; when the fire broke out the leaden pipe was soon melted and caused all the oil to flow out of the tank. An immense body of flame found its way upstairs and destroyed the whole of the upper portion of the building, including the roof.

There was no means of escape from the upper portion of the back of the house, as windows overlooking the convent grounds were forbidden. The house consisted of a shop, parlour, and kitchen on the ground floor, with two storeys over each, of one room only; it was made of wood and lath and plaster, and was described as a veritable death-trap.

The coroner's jury returned a verdict that deceased died from suffocation and burns, that there was no evidence to show how the fire occurred, and they added a rider to the effect that oil shops and places where inflammable materials are kept should be under the control of the London County Council or other authorities.

Oil stores, 64, Greenwich Road, S.E.

On 22nd September the occupier of oil stores at 64, Greenwich Road, S.E., in taking down some goods from a top shelf, knocked over a large *oil lamp*, which fell on the floor and broke. The oil ignited, and the flames quickly spread to the whole shop. The customers and the occupier rushed out into the road, and an assistant who was in the cellar at the time dashed through the flames to the upper rooms and rescued his wife and two children.

He was only just in time, for, a minute later, the flames burst through the first floor windows.

The fire was got under in about an hour.

Irvine Street, Liverpool.

On 25th September a London and North-Western Railway lorry laden with "empties" was proceeding up Irvine Street, in the direction of Edge Hill Station. The lorry was in charge of a carter, and a youth was seated on one of the empties, which happened to be a barrel that had contained methylated spirits. The lad is said to have been smoking, and was seated on one end of the barrel. Suddenly a loud explosion occurred, which was heard a considerable distance off; he was hurled into the air, and blown clean over the lorry on to the pavement.

When picked up he was found to be much bruised about the face and arms, and was more or less in a helpless condition.

In former reports we have more than once mentioned accidents of this character, that is to say, accidents due to the introduction of a match or flame into the explosive atmosphere existing in the interior of a cask which had contained mineral or other spirit.

Foreign Petroleum Accidents.

America. Alton Junction, Illinois.

An accident occurred on 21st January on the Cleveland, Cincinnati, Columbus, and St. Louis Railway. An express which was behind time was travelling at the rate of about 40 miles an hour, and ran into an open siding at Alton, upon which a goods train, to which two oil tank cars were attached, was standing. The tanks burst with the force of the collision, and the oil became ignited. The flames spread rapidly to the freight trucks, the contents of which were destroyed. The driver of the express was burnt to death. Eight persons were killed and 60 injured, 13 of whom afterwards succumbed. The more serious explosion was preceded by a slight one in one of the tanks, the burning débris being scattered about in all directions, setting fire to the stockyard enclosure.

The crowd, seeing the wreck already caused by the fire, rushed forward with the object of preventing the flames from spreading to the other yards, when a second explosion of terrific force followed, fully 35,000 gallons of blazing oil, the contents of four other tanks, being shot up in the air. All those persons who happened to be within 100 yards of the spot found their chance of escape shut off, their clothing took fire, and several were burnt or scalded to death.

The damage to freight and rolling stock is estimated at £1,000,000.

Deutch-Pereg, in the comitat of Arad.

A carnival was being celebrated on 13th February by a dance in the largest room of the village inn, and almost all the inhabitants were present. While the dancing was at its height, a cask of petroleum in the cellar beneath suddenly caught fire and exploded (it is said) with terrible force, partly destroying the flooring of the crowded room. The ignited vapour generated by the explosion ascended and enveloped the dancers in a mass of fire. It seems more probable that the explosion occurred not in the cask, but in the explosive atmosphere of the lower room created by leakage of vapour.

Seventeen persons, stunned by the explosion, or overcome by the stifling fumes, were burned to death. Twelve others were greatly injured, and ten more sustained burns of a less serious nature.

The explosion was caused by some children going into the cellar with a candle.

Batoum. On board sailing ship "Athen."

On 18th March a serious fire broke out on board the sailing ship "Athen." The ship was laden with 34,000 poods of benzine and mineral oils. The captain lost his life, but the crew were saved, though two of the men were seriously burned.

Florence.

On 31st May a maid-servant, in order to light a charcoal fire, poured some petroleum into the stove. On applying a match the blaze from the petroleum set fire to her clothes. Seized with fright, she rushed into the room of her mistress, who was in bed.

The lady tried to render assistance, with the result that both she and her servant were enveloped in flames. In the panic of the moment, they threw themselves out of the window, and both were killed on the spot.

Naphtha Stores, Riga.

A serious explosion occurred in Messrs. Nobel Brothers' Naphtha Stores, Riga, early on the morning of 18th September 1893. The building and its contents were damaged and all the windows in the vicinity were shattered. When the firemen entered the building, which was in semi-darkness, the carelessness of some of the men, who carried lighted torches, caused a second explosion, by which 15 persons were seriously injured.

Tiflis.

On 20th November a fire broke out in one of the petroleum refineries at Tiflis, which was totally destroyed.

The flames spread to three other smaller ones, which were also burned to the ground.

A fifth and larger refinery was afterwards attacked by the fire, and suffered serious damage.

There was no loss of life.

The whole town was lighted up by the flames, which were visible from a great distance.

VIII.

Experiments.

Experiments.

We have not carried out any experiments during the year.

Large blast.

The only blasting operation on a large scale of which we have heard during the year as having been carried out in this country, was one which took place at the Dinorwic Quarries, Llanberis.

For many years a huge mass of rock, technically known as a "dyke," had frowned over one of the great Dinorwic quarries, and had menaced the safety of the men employed in the "galleries," below which, in a series of "terraces," it rose almost from the edge of the lake far up the steep breast of the mountain.

It was decided to remove the "dyke," and the necessary preparations, which had been in active progress for about three months, were accordingly made.

From three longitudinal tunnels in the solid rock, ten chambers, each 11 feet by 4 feet, were made and charged with about $2\frac{1}{2}$ tons of gelatine dynamite.

This was fired by a time fuze, and the effect of the charge was the displacement of about 180,000 tons of rock.

A dense white smoke clung for a while round the scene of the explosion, and when that cleared away, in the place of the "dyke" there was a great gap, in which glistened here and there pinnacles of splintered rock.

America. Big blast at Fort Lee Ferry.

An interesting description appears in the American papers of "one of the most imposing blasts that has ever taken place" in a quarry in that country, and which was carried out at a point about two miles north of the Fort Lee Ferry, by which the removal of 100,000 tons of rock, known as the "Palisades," was safely effected by a charge of 4,000 lbs. of dynamite.

The "Palisades," situated as described, are almost directly opposite Fort Washington, and formed an almost impenetrable barrier to the civilizing influences which have prevailed lower down the river.

The preparations for the blast continued for about six weeks, and consisted, in the first place, in drilling a tunnel near the base of the big rock, which towered 350 feet above the heads of the miners. This tunnel was extended about 30 feet into the solid rock, and was made just large enough for a man to crawl into. At that point the tunnel was made to change its course downward and obliquely for a distance of 60 feet.

Then it was carried back again straight through the rock wall until a vertical seam or split in the formation occurred, which offered an admirable resting place for the dynamite. This seam was followed down for a distance of about 30 feet, and in a commodious chamber, almost wholly modelled by nature, the workmen prepared a nest for the charge.

The charge was tamped, and fired by electricity.

The superintendent took up his position at a distance of about 300 feet, and when the charge was fired, the big column of rock was seen to sway for a moment, and then to rise up almost bodily and fall out towards the river's shore.

The blast was hardly felt at all in the surrounding country. The people who had left their homes found all their household goods intact on their return.

The "Palisades" were torn out for a distance of about 300 feet, and "Washington's Head," which had been a landmark for boatmen for many years, became a thing of the past.

We have the honour to be, Sir,
Your obedient Servants,

V. D. Majendie, Colonel, } Her Majesty's Chief Inspector of Explosives.

A. Ford, Colonel, } Her Majesty's Inspectors of Explosives.

J. H. Thomson, Captain, }

APPENDICES to Annual Report.

APPENDIX A.

TABLE of FACTORIES,* showing the CLASSES of EXPLOSIVES authorised to be made therein.

Class and Division.	Index Numbers of Factories.	No. of Factories under Continuing Certificate.	No. of Factories under License.		Total No. of Factories.
			Licensed previous to 1893.	Licensed during 1893.	
Class 1. (Gunpowder).	1, 2, 11, 13, 15, 19, 20, 21, 23, 24, 25, 26, 29, 30, 33, 34, 37, 38, 39, 40, 42, 48, 49,† 50, 127, 143, 154, 156.	24	4	—	28
„ „ and Class 2 (Nitrate Mixture).	53‡	1	—	—	1
Class 2. (Nitrate Mixture).	——	—	—	—	—
Class 3. (Nitro-compound). Division 1	141, 148, 155	—	3	—	3
„ „ „ Divisions 1 and 2	3, 151	1	1	—	2
„ „ „ Divisions 1 and 2 and Class 6 (Ammunition)	111	—	1	—	1
„ „ „ Divisions 1 and 2, Class 5 (Fulminate). Division 1, Class 6 (Ammunition) and Class 7 (Fireworks)	7	1	—	—	1
„ „ „ Division 2	14, 36, 130, 136, 142	2	3	—	5
„ (Nitro-compound). Division 2, and Class 6 (Ammunition)	9, 35, 122, 134, 135, 149	2	4	—	6
Class 4. (Chlorate Mixture). Division 1	——	—	—	—	—
„ „ „ „ 2	——	—	—	—	—
Class 5. (Fulminate). Division 1	12, 102	1	1	—	2
„ „ „ 1, and Class 6 (Ammunition) Division 1	58	—	1	—	1
„ (Fulminate). Division 1, and Class 6 (Ammunition) Divisions 1, 2, and 3	41, 114, 137	1	2	—	3
„ (Fulminate). Division 2	——	—	—	—	—
Class 6. (Ammunition). Division 1	44, 51, 56, 61, 62, 63, 67, 69, 70, 79, 104, 107, 115, 119, 126, 132.	2	14	—	16
„ „ Divisions 1 and 2	117, 124, 139	—	3	—	3
„ „ „ 1, 2, and 3	46, 47, 60, 116, 133, 138, 144.	2	5	—	7
„ „ Division 2	77, 81, 88, 92, 99, 100, 101, 103, 109, 110, 113, 118, 120, 128, 131, 140, 146, 152.	—	18	—	18
„ „ Divisions 2 and 3	18, 80, 86, 95, 125, 150, 157.	1	5	1	7
„ „ and Class 7 (Fireworks)	16, 65, 73, 89, 98	1	4	—	5
Class 7. (Fireworks). Divisions 1 and 2	8, 32, 55, 57, 72, 76, 78, 84, 87, 94, 96, 108, 121, 123, 129, 145, 147, 153.	3	15	—	18
	Total	42	84	1	127

* Not including Toy Firework Factories (for number of which see Appendix B.).
† Factory 49 also by Amending License can manufacture Ammunition, Divisions 1 and 2, for experimental purposes only.
‡ Safety Blasting Powder added by Amending License.

APPENDIX B.

TABLE of EXPLOSIVES authorised to be manufactured, with the number of FACTORIES and TOY FIREWORK FACTORIES in which each may be made.

Class and Name of Explosive			Index Numbers of Factories.	No. of Factories in which each may be made.
Class 1.	Gunpowder		1, 2, 11, 13, 15, 19, 20, 21, 23, 24, 25, 26, 29, 30, 33, 34, 37, 38, 39, 40, 42, 48, 49, 50, 53, 127, 143, 154, 156.	29
Class 2.	Safety Blasting Powder		53	1
Class 3.	Division 1.	Dynamite (Nos. 1 and 2)	3, 7, 111, 141, 148	5
„	„	Carbo-dynamite	148	1
„	„	Carbonite	3	1
„	„	Blasting Gelatine (Nos. 1 and 2)	3, 7, 141, 148	4
„	„	Gelatine Dynamite (Nos. 1 and 2)	3, 7, 141, 148	4
„	„	Primers for Gelatine	3, 148	2
„	„	Lithofracteur	111	1
„	„	Ballistite	3, 155	2
„	„	Ardeer Powder	3	1
„	„	Camphorated Gelatine	3	1
„	„	Oarite	7	1
„	„	Amberite No. 1	151	1
„	Division 2.	Guncotton	3, 7, 9, 14,* 35, 111,* 122, 135	8
„	„	Nitrated Guncotton	9, 14,* 111,* 122, 135	5
„	„	Tonite or Cotton Powder (Nos. 1 and 2).	7, 35, 135	3
„	„	Tonite or Cotton Powder (No. 3)	7	1
„	„	Potentite	7, 35	2
„	„	Sawdust and Guncotton Powder	35	1
„	„	Rifle Guncotton	9, 14,* 122, 135	4
„	„	E. C. Sporting Powder	9, 122, 135	3
„	„	E. C. Powder Co's Rifle Powder, J. B. Patent.	122	1
„	„	Amberite No. 2	151	1
„	„	Schultze Gunpowder	36, 135	2
„	„	Schultze Blasting Powder	36, 135	2
„	„	Sawdust Gunpowder	35	1
„	„	Rifleite	135	1
„	„	Roburite (Nos. 1 and 2)	130	1
„	„	Securite	134	1
„	„	Compressed Securite	134	1
„	„	Denaby Powder	134	1
„	„	Gathurst Powder	130	1
„	„	Di-Flamyr	135	1
„	„	Cooppal's Powder	135	1
„	„	Smokeless Powder	135	1
„	„	Smokeless Blasting Powder	135	1
„	„	Ammonite	142	1
„	„	Cannonite (Nos. 1 and 2)	149	1
„	„	Picric Acid	136	1
Class 5.	Division 1.	Fulminate of Mercury	7, 12, 41, 58, 102, 114	6
Class 6.	Division 1.	Safety Cartridges	7, 9, 16, 35, 41, 46, 47, 58, 65, 115,‖ 116, 117, 122, 124, 132, 133, 135, 137, 138, 139, 144, 149.	22
„	„	Safety Fuze	56, 60, 61, 62, 63,‡ 67, 69, 70, 79	9
„	„	Railway Fog Signals	7, 41, 44, 46, 47, 65, 73, 89, 104, 107, 114, 119, 137, 138.	14
„	„	Percussion Caps	41, 46, 47, 51, 58, 114, 116, 137, 144	9
„	„	Tube Safety Fuze	126	1
„	„	Safety Firing Tubes, No. 1	7	1
„	Division 2.	Cartridges for Small Arms†	9, 15, 41, 44, 46, 47, 109, 114, 116, 122, 135, 138, 149.	13
„	„	Cartridges for Cannon, Blasting, &c.§	46, 47, 65, 77, 81, 88, 89, 92, 99, 100, 101, 103, 109, 110, 117, 120, 125, 128, 131, 133, 135, 138, 139, 140, 146, 152.	26
„	„	Electric Fuzes	7, 18, 65, 86, 95, 111, 134, 138, 150, 157	10
„	„	Instantaneous Fuze	60	1

* Preparing for use only.
† Not including "rooms" used in connexion with magazines, stores, or registered premises under Section 46.
‡ Preparing gunpowder for use only in the manufacture of safety fuze.
§ Not including the factories in which, under Section 44, they may be made without a license, or the "workshops" used in connexion with magazines and stores under Section 47.
‖ Capping of empty cartridges and miscellaneous operations connected with the manufacture of cartridge cases only.

Class and Name of Explosive.			Index Numbers of Factories.	No. of Factories in which each may be made.
Class 6.	Division 2.	Bickford's Patent Volley Firers	60	1
,,	,,	Metallic Blasting Fuze	118	1
,,	,,	Tubes for firing Explosives	65, 80, 138	3
,,	,,	Electric Tubes	80, 95, 138	3
,,	,,	Electric Primers	41	1
,,	,,	Shells	47, 125, 138, 146	4
,,	,,	Fuzes for Shells	41, 46, 47, 65, 80, 137, 138	7
,,	,,	German Spills	80, 98	2
,,	,,	Miners' Squibs	113, 150	2
,,	,,	War Rockets	65	1
,,	Division 3.	Detonators	7, 18, 41, 46, 137, 138	6
,,	,,	Cartridges for Small Arms*	9, 41, 46, 47, 114, 116, 135, 144	8
,,	,,	Tubes for firing Explosives	46, 65, 80, 138	4
,,	,,	Electric Detonator Fuzes	7, 18, 65, 86, 111, 134, 138, 150, 157	9
,,	,,	Electric Detonators	138	1
,,	,,	Fuzes for Shells	41, 46, 47, 65, 80, 114	6
,,	,,	Safety Firing Tubes, No. 2	7	1
,,	,,	Colliery Safety Lighters	60	1
,,	,,	Quick-Firing Ammunition†	41, 46, 47, 65, 114, 133, 137, 138	8
,,	,,	Metallic cartridges containing gunpowder.‡	125	1
Class 7.	Fireworks		7, 8, 16, 32, 55, 57, 65, 72, 73, 76, 78, 84, 87, 89, 94, 96, 98, 108, 121, 123, 129, 145, 147, 153.	24
			Toy Firework Factories, 3, 13, 14, 15, 17, 19, 20, 23, 24, 25, 26.	11

* Not including "rooms" used in connexion with magazines, stores, or registered premises under Section 46.

† For Her Majesty's Land and Sea Forces only, and in case of Factory 138 for direct exportation, or private sale, and Factory 47 for private sale.

‡ For use on adjoining range only.

APPENDIX C.

TABLE of EXPLOSIVES authorised to be manufactured, with the number of FACTORIES in which each could be made at the end of each year since the passing of the Act.

Class.	Division.	Name of Explosive.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
1	—	Gunpowder	29	29	28	28	28	28	28	28	28	28	28	29	28	29	29	29	30	29
2	—	Espir's Explosive Powder,	—	—	1	1	1	1	1	1	1	1	—	—	—	—	—	—	—	—
		Pudrolithe	1	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
		Safety Blasting Powder.	—	—	—	—	—	—	1	1	1	1	1	1	1	1	1	1	1	1
3	1	Ardeer Powder	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1
		Amberite, No. 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
		Ballistite	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	2	2
		Blasting Gelatine (No. 1 and 2).	—	—	—	—	1	1	1	1	1	1	1	1	1	1	2	2	3	4
		Camphorated Gelatine.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1
		Carbo-dynamite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1
		Carbonite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
		Dynamite (Nos. 1 and 2).	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	4	4	5
		E. C. Dynamite	—	—	—	—	—	—	—	1	1	1	1	—	—	—	—	—	—	—
		Gelatine Dynamite (Nos. 1 and 2).	—	—	—	—	—	—	—	1	1	1	1	1	1	1	2	2	3	4
		Lithofracteur	—	—	—	—	—	—	1	1	1	1	1	1	1	1	1	1	1	1
		Oarite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1
		Primers for Gelatine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	2

Class.	Division.	Name of Explosive.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
3	2	Amberite No. 2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
		Ammonite	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
		Cannonite, Nos. 1 and 2.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
		Collodion Cotton	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Compressed Securite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1
		Cooppal's Powder	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
		Cotton Gunpowder	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Denaby Powder	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1
		Diflamyr	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
		E.C. Sporting Powder.	—	—	—	—	—	—	1	1	2	2	2	2	2	3	3	3	3	3
		E.C. Sporting Powder, J.B. Patent.	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—
		E.C. Powder Co.'s Rifle Powder.	—	—	—	—	—	—	1	1	2	2	2	2	2	3	—	—	—	—
		E.C. Powder Co.'s Rifle Powder, J.B. Patent.	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1
		Flameless Securite	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
		Gathurst Powder	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1
		Guncotton	4	5	5	5	5	4	5	5	6	6	6	6	6	7	7	8	8	8
		Nitrated Guncotton	2	3	3	3	3	2	3	3	4	4	4	4	4	5	5	5	5	5
		Picric Acid	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
		*Potentite	—	—	—	—	1	1	1	1	1	1	1	1	2	2	2	2	2	2
		Rifleite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1
		Rifle Guncotton	2	3	3	3	3	2	2	2	3	3	3	3	3	4	4	4	4	4
		Roburite, Nos. 1 and 2.	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1
		Sawdust and Guncotton Powder.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Sawdust Gunpowder	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Schultze Gunpowder	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
		Schultze Blasting Powder.	1	1	1	1	1	1	1	1	1		1	1	1	2	2	2	2	2
		Securite	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
		Smokeless Powder	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
		Smokeless Blasting Powder.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1
		Tonite or Cotton Powder, Nos. 1 and 2.	1	1	1	1	1	1	1	1	1	1	1	1	2	3	3	3	3	3
		Tonite or Cotton Powder No. 3.	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
		Wood Gunpowder	—	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—
		Xylobrome	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	1	Fulminate of Mercury.	2	2	2	2	3	3	4	5	5	5	5	5	5	5	5	6	6	6
6	1	Percussion Caps	6	6	6	5	5	5	5	7	7	8	8	8	8	9	10	10	9	9
		Railway Fog Signals	5	5	5	6	8	8	8	9	10	10	12	12	12	14	14	14	14	14
		Safety Cartridges	9	8	8	8	8	8	9	12	12	13	13	13	15	19	21	22	22	22
		Safety Firing Tubes No. 1.	—	—	—	—	—	—	—	—	...	—	—	1	1	1	1	1	1	1
		Safety Fuze	5	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
		Tube Safety Fuze	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1	1
6	2	†Bickford's Patent Volley Firers.	—	—	—	—	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		‡Cartridges for Small Arms.	4	4	4	4	4	4	6	8	8	8	8	8	8	10	13	13	13	13
		§Cartridges for Cannon, Blasting, &c.	3	7	7	9	13	13	14	15	16	16	18	19	21	25	25	25	26	26
		Electric Fuzes	—	1	2	2	3	3	4	4	4	6	6	6	6	6	8	8	9	10
		Electric Primers	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
		Electric Tubes	—	—	—	1	1	2	2	2	2	2	2	2	2	2	2	2	3	3
		Fuzes for Shells	1	2	2	2	2	2	2	2	2	3	3	3	3	5	5	6	6	7
		German Spills	—	—	—	1	1	1	2	2	2	2	2	2	2	2	3	3	3	2
		Guncotton Fuzes	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Gunpowder Fuzes	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Hunters Patent Miners' Fuzes.	—	—	—	—	—	—	1	1	1	1	—	—	—	—	—	—	—	—
		Instantaneous Fuze	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Metallic Blasting Fuze.	—	—	—	1	1	1	—	1	1	1	1	1	1	1	1	1	1	1
		Miners Squibs	—	—	—	—	—	—	1	1	1	1	1	1	1	1	1	1	2	2
		Shells	—	—	—	—	—	—	—	—	—	1	2	2	2	2	2	4	4	4
		Tubes for Firing Explosives.	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3
		War Rockets	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1

* First known as Liverpool Cotton Powder or Potentite.
† First known as Patent Igniters.
‡ Not including "rooms" in connexion with Magazine Stores and Registered Premises under Section 46.
§ Not including the factories in which, under Section 44, they may be made without a license, or the "Workshops" used in connexion with Magazines and Stores under Section 47.

Class.	Division.	Name of Explosive.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
6	3	*Cartridges for Small Arms.	3	3	3	3	3	3	3	5	5	5	5	5	5	5	6	8	8	8
		Colliery Safety Lighters.	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1	1
		Detonators - -	2	4	4	4	3	3	4	4	4	4	4	4	4	5	6	6	7	6
		Double Detonator Fuzes.	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Electric Detonators	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
		Electric Detonator Fuzes.	—	—	2	2	2	2	3	3	3	5	5	5	5	5	7	7	8	9
		Fuzes for Shells -	1	2	2	2	2	2	2	2	2	3	3	3	5	5	5	6	6	6
		†Metallic Cartridges containing Gunpowder.	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1	1
		‡Quick Firing Ammunition.	—	—	—	—	—	—	—	—	—	—	—	2	6	8	8	8	8	8
		Safety Firing Tubes, No. 2.	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1	1	1
		Socket Light - -	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
		Sound Signal Rockets	—	—	—	—	—	—	1	1	1	1	1	1	1	1	1	1	—	—
		Sound Socket Signals	—	—	—	—	1	1	1	1	1	1	1	1	1	—	—	—	—	—
		Tubes for Firing Explosives.	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4
7	—	Fireworks - -	12	18	20	24	25	24	25	24	24	25	25	23	24	24	24	25	26	24
		Toy Fireworks -	—	—	9	14	15	14	13	13	13	13	16	13	12	12	12	10	11	11

* Not including "rooms" used in connexion with Magazines, Stores, and Registered Premises under Section 46.
† For use on an adjoining range only.
‡ For Her Majesty's Land and Sea Forces; extended in 1892 to private sale and direct exportation in certain cases.

APPENDIX D.

The following explosives are at present authorised for manufacture in or importation into the United Kingdom.

Where the definition is derived from the Act a reference is given in italics to the section of the Act or to the Order in Council containing such definition. When no such reference appears the definition is quoted from a current license (whether for manufacture or importation) affecting that explosive. For the factories in which the various explosives may be manufactured *see* Appendix B, and for importation licenses for the various explosives *see* Appendix K.

Class 1.—Gunpowder

Gunpowder, ordinarily so called. *O. in C., No.* 1.

Class 2.—Nitrate Mixture.

Chilworth Special Powder, consisting of a mechanical mixture of nitrate of potassium, nitrate of ammonium, and charcoal, with or without the addition of sulphur.

Fortis Explosive, consisting of a mixture of two or more of the following substances, viz., tan, lampblack, and sulphur, such mixture being thoroughly impregnated with a mixture of nitrate of potassium and proto-sulphate of iron, and with or without the addition to such impregnated mixture of glycerine.*

Safety Blasting Powder,† consisting of a mechanical mixture of saltpetre, sulphur, lampblack, sawdust, and sulphate of iron.

Class 3.—Nitro-Compound.

Division 1.

Amberite No. 1,‡ consisting of thoroughly purified nitro-cellulose mixed or combined with the following substances:—

Thoroughly purified nitro-glycerine.
Paraffin free from mineral acid.
Shellac.

The whole to be of such character and consistency as not to be liable to liquefaction or exudation.

* This explosive is authorised for importation and issue only in the form of compressed cartridges, such cartridges being rendered thoroughly waterproof (*a*) by waterproofing the naked compressed cartridges, and (*b*) by enclosing such waterproofed compressed cartridges in a thoroughly waterproof cartridge case.
† Manufacture suspended.
‡ For Amberite No. 2, see p. 82,

Ardeer Powder, consisting of dynamite No. 1, as herein defined, mixed or incorporated with sulphate of magnesium, with or without the addition of nitrate of potassium, nitrate of sodium, nitrate of barium, or such other nitrates as may from time to time be approved by the Secretary of State.

Ballistite, consisting of nitro-cellulose, carefully washed and purified, combined with thoroughly purified nitro-glycerine, with or without the addition of camphor, aniline, and such other substance, and solvent (if any) as may from time to time be approved by a Secretary of State, and with or without carbonate of calcium or carbonate of magnesium, not exceeding 1 part by weight in every 100 parts by weight of the finished explosive, the whole to be of such character and consistency as not to be liable to liquefaction or exudation.

Blasting Gelatine No. 1, consisting of nitro-cellulose, carefully washed and purified, combined with thoroughly purified nitro-glycerine in such proportions that the whole shall be of such character and consistency as not to be liable to liquefaction or exudation, and with or without carbonate of calcium or carbonate of magnesium not exceeding 1 part by weight in every 100 parts by weight of the finished explosive.

Blasting Gelatine No. 2, consisting of blasting gelatine No. 1 as above defined, mixed or incorporated with nitrate of potash (with or without charcoal), or such other nitrate as may for the time being be sanctioned by a Secretary of State.

Blasting Matagnite, consisting of nitro-cellulose, carefully washed and purified, combined with thoroughly purified nitro-glycerine, and thoroughly purified nitro-benzole, or either of them, in such proportions that the whole shall be of such character and consistency as not to be liable to liquefaction or exudation.

Camphorated Gelatine, consisting of blasting gelatine, No. 1, as above defined, mixed or incorporated with camphor.

Carbo-Dynamite, consisting of not more than 90 parts by weight of thoroughly purified nitro-glycerine, uniformly mixed with 10 parts by weight of charcoal sufficiently absorbent in quality when mixed in the above proportions to prevent exudation of the nitro-glycerine; whether with or without the addition of one or more of the following substances, viz., nitrate of potassium, nitrate of barium, carbonate of sodium, and carbonate of ammonium, provided that the proportion of carbonate present shall not exceed 1½ parts by weight in every 100 parts by weight of the finished explosive.

Carbonite, consisting of not more than 25 parts by weight of thoroughly purified nitro-glycerine (with or without the addition of not more than half a part of sulphuretted benzole), uniformly mixed with 75 parts by weight of a pulverized preparation consisting of wood meal, not less than 40 parts; nitrate of potassium, nitrate of sodium, and nitrate of barium (one or more of them) 34 parts; and carbonate of sodium and carbonate of lime (or either of them), not more than half a part, such preparation to be sufficiently absorbent when mixed in the above proportions to prevent exudation of nitro-glycerine.

Dynamite No. 1, consisting of not more than 75 parts by weight of thoroughly purified nitro-glycerine, uniformly mixed with 25 parts by weight of—

(*a*) An infusorial earth, known as "kieselguhr," or

(*b*) A non-explosive mixture of kieselguhr with such other ingredients and in such proportions as may for the time being be sanctioned by the Secretary of State; *e.g.*,

Carbonate of sodium Sulphate of barium Mica Talc Ochre	8 parts (or less) by weight, in substitution for an amount by weight of kieselguhr.

Provided:—

(1.) That the said (*a*) kieselguhr, *or* (*b*) non-explosive mixture, shall be sufficiently absorbent is quality when mixed in the above proportions to prevent exudation of nitro-glycerin. and

(2.) That there may be added to the kieselguhr or non-explosive mixture an amount of carbonate of ammonium not exceeding 1½ parts by weight in every 100 parts by weight of the finished dynamite.

Dynamite No. 2, consisting of not more than 18 parts by weight of thoroughly purified nitro-glycerine, uniformly mixed with 82 parts by weight of a pulverized preparation, composed of nitrate of potash 71 parts, charcoal not less than 10 parts, and purified paraffin (or Ozokerit) 1 part (*or* nitrate of potash 72 parts, and charcoal not less than 10 parts) by weight and sufficiently absorbent in quality when mixed in the above proportions to prevent exudation of nitro-glycerine.

Forcite, consisting of thoroughly purified nitro-glycerine, thickened by being combined with nitro-cellulose, carefully washed and purified, and mixed or incorporated with wood meal and nitrate of potassium in such proportions that the whole shall be of such character and consistency as not to be liable to liquefaction or exudation.

Gelatine Dynamite No. 1, consisting of thoroughly purified nitro-glycerine, thickened by being combined with nitro-cellulose, carefully washed and purified, and mixed or incorporated with one

or more of the following non-explosive ingredients, viz., cotton, charcoal, or such other ingredients as may for the time being be sanctioned by a Secretary of State, and in such proportions that the whole shall be of such character and consistency as not to be liable to liquefaction or exudation.

Gelatine Dynamite No. 2, consisting of gelatine dynamite No. 1 as above defined, mixed or incorporated with nitrate of potash or such other nitrate as may for the time being be sanctioned by a Secretary of State.

Lithofracteur, consisting of not more than 55 parts by weight of thoroughly purified nitro-glycerine, uniformly mixed with 45 parts by weight of a pulverized preparation, consisting of 1 part by weight of charcoal, bran, and sawdust (*or* of any one or more of the same), 3½ parts by weight of an infusorial earth known as Kieselguhr, 2½ parts by weight of nitrate of baryta and bicarbonate of soda (*or* of either of them), ½ part by weight of sulphur and manganese (*or* of either of them), and sufficiently absorbent in quality when mixed in the above proportions to prevent exudation of nitro-glycerine.

Matagnite Gelatine, consisting of thoroughly purified nitro-glycerine, and thoroughly purified nitro-benzole, or either of them, thickened by being combined with nitro-cellulose carefully washed and purified, and mixed or incorporated with wood meal for the bleaching or purifying of which no chemical agents have been used, or if used have been absolutely removed, and nitrate of potassium or such other nitrate as may for the time being be sanctioned by a Secretary of State, in such proportions that the whole shall be of such character and consistency as not to be liable to liquefaction or exudation.

Oarite, consisting of not more than 2 parts by weight of thoroughly purified nitro-glycerine uniformly mixed with 8 parts by weight of the following preparation, viz.:—

Thoroughly purified nitro-cellulose 1 part, thoroughly purified di-nitro-benzole 1 part, nitrate of barium or nitrate of potassium or either of them, 6 parts.

Provided that the said preparation shall be sufficiently absorbent in quality when mixed in the above proportions to prevent exudation of nitro-glycerine.

Primers for Gelatines, consisting of not more than fifty (50) parts by weight of thoroughly purified nitro-glycerine uniformly mixed with fifty (50) parts by weight of thoroughly purified nitro-cellulose, and with or without carbonate of calcium or carbonate of magnesium, the whole to be of such character as not to be liable to liquefaction or exudation of nitro-glycerine, even when entirely immersed in water and subjected to a constant pressure of not more than 2½ pounds on each primer.

Stonite, consisting of not more than 68 parts by weight of thoroughly purified nitro-glycerine, uniformly mixed with 32 parts by weight of a preparation consisting of nitrate of barium, nitrate of potassium (or either of them), kieselguhr (not less than 20 parts by weight), wood meal (not less than 4 parts by weight), and carbonate of magnesia, with or without the addition of sulphuretted oil and soot (or either of them), such preparation to be sufficiently absorbent when mixed in the above proportions to prevent exudation of nitro-glycerine.

Division 2.

Amberite No. 2, consisting of thoroughly purified nitro-cellulose, whether or not mixed or impregnated with nitrate of potassium and nitrate of barium, or either of them, and with or without the addition of paraffin, vaseline, and graphite, or such other substance as may from time to time be approved by a Secretary of State.

Ammonite,* consisting of a mixture of nitrate of ammonium and thoroughly purified mono-nitro-naphthaline, or di-nitro-naphthaline, or a mixture of the two last-named ingredients made up into cartridges for blasting not containing their own means of ignition, contained or enclosed in a thoroughly waterproof case.

Bellite, consisting of a mixture of nitrate of ammonium and thoroughly purified meta-di-nitro-benzole.

B. N. Powder, consisting of thoroughly purified nitro-cellulose and tannin, partly gelatinized, incorporated with nitrate of barium and nitrate of potassium.

Cannonite No. 1, consisting of gun-cotton (consisting of thoroughly purified nitro-cellulose), mixed or impregnated with a nitrate or nitrates (other than nitrate of lead or nitrate of ammonium) and rosin, and with or without the addition of graphite.

Cannonite No. 2, consisting of gun-cotton (consisting of thoroughly purified nitro-cellulose) mixed or impregnated with rosin, and with or without the addition of graphite.

Chilworth Smokeless Powder, consisting of thoroughly purified nitro-cellulose gelatinized by a suitable process, and with or without the addition of nitrates (other than nitrate of ammonium).

Compressed Securite, consisting of a mixture of nitrate of potassium and nitrate of barium (or either of them) with thoroughly purified nitro-cellulose and one or more of the following substances:—

Thoroughly purified meta-di-nitro-benzole.
Thoroughly purified di-nitro-toluol.
Thoroughly purified nitro-naphthaline.
Thoroughly purified di-nitro-naphthaline.

* This explosive is authorized for manufacture and issue only in the form of cartridges for blasting not containing their own means of ignition, contained or enclosed in thoroughly waterproof cases.

Cooppal's Powder, consisting of nitro-lignin carefully purified with or without admixture of a nitrate or nitrates (other than nitrate of lead or nitrate of ammonium) and starch.

C. L. Powder, consisting of nitro-cellulose thoroughly purified.

Denaby Powder, consisting of compressed securite, as above defined, with the addition of charcoal.

Di-flamyr, consisting of nitro-cellulose thoroughly purified, mixed or impregnated with a nitrate or nitrates other than nitrate of lead or nitrate of ammonium.

E.C. Sporting Powder, consisting of thoroughly purified nitro-cellulose mixed or impregnated with a nitrate or nitrates (other than nitrate of lead), with the addition of colouring matter consisting of aurine or ultramarine, both free from free mineral acid, and with or without the addition of any one or more of the following substances, viz., camphor, pure bees-wax, paraffin, shellac, gums, or resins (or such other substance as may from time to time be approved by a Secretary of State), dissolved in benzoline or other volatile solvent, such substances to be free from free mineral acid.

E.C. Powder Company's Rifle Powder, J. B. Patent, consisting of thoroughly purified nitro-cellulose mixed or impregnated with a nitrate or nitrates (other than nitrate of lead), with the addition of lampblack free from mineral acid or charcoal, and with or without the addition of camphor dissolved in benzoline or other volatile solvent.

Fortisine, consisting of a mixture of saltpetre, sulphur, and charcoal, with the addition of a di-nitro-benzole and resin or dextrine, provided 1st, that the amount of di-nitro-benzole shall not exceed 5 per cent. of the finished explosive; and 2nd, that all the ingredients shall be thoroughly purified.

Gathurst Powder, consisting of a mixture of (*a*) nitrate of potassium or nitrate of sodium with or without the admixture of neutral sulphate of ammonium, nitrate of ammonium, chloride of ammonium, sulphate of magnesium, and a colouring matter such as charcoal or lampblack (free from mineral acid), or all or any of them; and (*b*) thoroughly purified nitro and chloro-nitro compounds of benzine, toluene, and naphthaline with or without such other substances as may from time to time be approved by a Secretary of State. Provided that the finished explosive shall not contain more than two parts by weight of chlorine in every 100 parts of the finished explosive.

Guncotton, consisting of nitro-cellulose thoroughly purified,* with or without the addition of carbonate of calcium.

Greener's Powder, consisting of a mixture of thoroughly purified nitro-cellulose with thoroughly purified nitro-benzole, or either of them, with the addition of colouring matter consisting of graphite, lampblack, or other suitable material, such colouring matter to be free from free mineral acid.

Nitrated Guncotton, consisting of thoroughly purified guncotton mixed or impregnated with a nitrate or nitrates other than nitrate of lead.

Picric acid, consisting of tri-nitro-phenol containing not more than 0·5 per cent. of mineral matter or ash.

Potentite, consisting of guncotton thoroughly purified, mixed or impregnated with a nitrate or nitrates.

Rifleite, consisting of thoroughly purified nitro-lignin, dissolved in a safe and suitable solvent, with or without nitro-benzine and di-nitro-benzine, mixed or impregnated with a nitrate or nitrates (other than nitrate of lead and ammonium nitrate), or not so mixed or impregnated, and with or without the addition of graphite.

Rifle Guncotton, consisting of thoroughly purified guncotton, whether or not mixed with a nitrate or nitrates, other than nitrate of lead, mixed with any one or more of the following substances, viz., pure bees-wax, paraffin, shellac, gum, or resins dissolved in a solvent composed of ether, alcohol, and benzoline, and such substances to be free from free mineral acid.

Roburite No. 1, consisting of (*a*) nitrate of ammonium with or without an admixture of nitrate of sodium and neutral sulphate of ammonium, or either of them, provided that the amount of nitrate of sodium shall in no case exceed 50 per cent. of the total amount of nitrates present; and (*b*) thoroughly purified chlorinated di-nitro-benzole with or without the addition of thoroughly purified chloro-nitro-naphthaline and chloro-nitro-benzole; provided (1) that such chlorinated di-nitro-benzole shall not contain more than four (4) parts by weight of chlorine to every one hundred (100) parts by weight of chlorinated di-nitro-benzole; and (2) that the proportions of chloro-nitro-naphthaline and chloro-nitro-benzole shall not amount to more than 2 per cent. and 5 per cent. respectively of the finished explosive.

Roburite No. 2, consisting of Roburite No. 1, as above defined, with the addition of chloride of ammonium and sulphate of magnesium, or either of them.

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* Some factories and magazines are still licensed for guncotton as formerly defined, "consisting of guncotton thoroughly purified." This also applies to explosives in which guncotton enters as an ingredient.

Sawdust and Guncotton Powder, consisting of a mixture of two or more of the following explosives, viz., sawdust gunpowder,* guncotton, cotton gunpowder.†

Securite, consisting of a mixture of nitrate of potassium, or nitrate of ammonium with thoroughly purified meta-di-nitro-benzole with or without the addition of oxalate of ammonium.

Schultze Gunpowder, consisting of nitro-lignin carefully purified and mixed or impregnated with a nitrate or nitrates, other than nitrate of lead, or nitrate of ammonium, and with or without starch or collodion (such collodion to consist of carefully purified nitro-lignin dissolved in a safe and suitable solvent), or pure solid paraffin, provided that such paraffin shall be free from mineral acid.

Schultze Blasting Powder, consisting of Schultze gunpowder as above defined mixed with charcoal or sugar.

Smokeless Powder, consisting of nitro-lignin carefully purified and mixed or impregnated with a nitrate or nitrates (other than nitrate of lead and ammonium nitrate), and with or without starch or collodion or turmeric or similar vegetable colouring matter, provided that such collodion shall consist of carefully purified nitro-lignin dissolved in a safe and suitable solvent, and with or without such other substance as may from time to time be approved by a Secretary of State.

Smokeless Blasting Powder, consisting of smokeless powder as above defined, with the addition of any one or more of the following ingredients, viz., di-nitro-benzole, di-nitro-toluol, nitro-benzole, and nitro-naphthaline, provided that all such ingredients shall be thoroughly purified.

Tonite or Cotton Powder No. 1, consisting of guncotton thoroughly purified, mixed or impregnated with a nitrate or nitrates.

Tonite or Cotton Powder No. 2, consisting of guncotton thoroughly purified, mixed or impregnated with a nitrate or nitrates and charcoal.

Tonite or Cotton Powder No. 3, consisting of a mixture of thoroughly purified meta-di-nitro-benzole, and thoroughly purified guncotton, mixed or incorporated with one or more of the following ingredients, namely, nitrate of potassium, nitrate of sodium, nitrate of barium, and chalk.

Walsrode Powder, consisting of thoroughly purified nitro-cellulose, mixed with carbonate of calcium, and gelatinized by a suitable process.

Class 4.—Chlorate Mixture.

Nil.

Class 5.—Fulminate

Fulminate of Mercury. *O. in C., No.* 1.

Cap Composition, consisting of chlorate of potash and sulphide of antimony or sulphur, with or without fulminate of mercury and ground glass.‡

Class 6.—Ammunition.

Division 1.

Percussion Caps. *O. in C., No.* 1.

Railway Fog Signals, of such strength and construction, and containing an explosive in such quantity that the explosion of one such railway fog signal will not communicate the explosion to other like railway fog signals.

Safety Cartridges, consisting of cartridges for small arms, of which the case can be extracted from the small arm after firing, and which are so closed as to prevent any explosion in one cartridge being communicated to other cartridges. *Section* 108.

Safety Fuze, consisting of a fuze for blasting, which burns and does not explode, and which does not contain its own means of ignition, and which is of such strength and construction, and contains an explosive in such quantity that the burning of such fuze will not communicate laterally with other like fuzes. *O. in C., No.* 1.

Safety Firing Tubes, No. 1, consisting of a tube of metal or other suitable material, containing a percussion cap and suitable mechanical appliances for firing the same.

Tube Safety Fuze, consisting of a pipe or tube of pewter, coated externally with tarred yarns, tapes, or other suitable covering, and containing gunpowder in the proportion of not more than one and a half (1½) ounces to every twenty-four (24) feet of fuze.

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* Defined as consisting of nitro-lignin thoroughly purified, mixed, or impregnated with a nitrate or nitrates.

† Cotton gunpowder is identical with Tonite or Cotton Powder No. 1 or Potentite.

‡ Licensed, under special restrictions, for one factory only (No. 12), and for the supply of neighbouring ammunition factories, not for general sale. Similar compositions are mixed at various ammunition factories, but forthwith placed into percussion caps, &c. on the premises. At the factory in question, fulminate of mercury and cap composition are the only manufactures carried on.

Division 2.

(*Not containing its own means of ignition.*)

Cartridges for Small Arms (which are not Safety Cartridges). *O. in C., No.* 1.

Cartridges for Cannon, Shells, Mines, Blasting or other like purposes. *O. in C., No.* 1; also *Section* 44.

Abel's Electric Fuzes, consisting of a case of wood or other suitable material, containing two insulated wires, the terminals of which are (*a*) embedded in a charge, not exceeding two grains of the priming composition No. 1, herein-after specified, or (*b*) connected by a bridge of fine wire composed of a platinum alloy, steel, or other suitable material, the said bridge being embedded in a charge, not exceeding 10 grains of the priming material No. 2, herein-after specified; the case being either (*a*) filled with a charge not exceeding 20 grains of gunpowder and closed at the end, or (*b*) empty and open at the end, or (*c*) fitted with a small hollow cylinder of copper, sheet tin, or other material suitable for conversion into a detonator.

Priming composition, No. 1, consisting of sulphide of copper, phosphide of copper, and chlorate of potash, intimately mixed together.

Priming composition, No. 2, consisting of gunpowder and thoroughly purified guncotton.

Brain's Electric Fuzes, consisting of a case of wood or other suitable material, containing two insulated copper wires, the terminals of which are embedded in a priming composition consisting of an intimate mixture of chlorate of potash, native sulphide of antimony, and sub-phosphide of copper.

Electric Fuzes (Smith's Patent), consisting of a plug of sulphur containing two copper wires connected by a bridge of fine platinum or other suitable wire surrounded by a priming charge of fulminate of mercury not exceeding one-fifth of a grain in any one fuze.

High Tension Electric Fuzes, consisting of a case of wood or other suitable material, containing two insulated wires, the terminals of which are embedded in a charge not exceeding two grains of a priming composition, consisting of sulphide of copper, phosphide of copper, and chlorate of potash intimately mixed together, the case being filled with a charge not exceeding 20 grains of gunpowder or carefully purified collodion cotton, and closed at the end.

High Tension Electric Fuzes, consisting of a plug of wood or other suitable material containing two insulated copper wires, the terminals of which are embedded in a priming composition, consisting of an intimate mixture of chlorate of potassium, sulphide of antimony, silver precipitate, and plumbago.

High Tension Electric Fuzes (Brain's Patent), consisting of a case of wood or other suitable material, containing two insulated copper wires, the terminals of which are embedded in a priming composition, consisting of an intimate mixture of chlorate of potash, native sulphide of antimony, platinum, and silver.

Low Tension Electric Fuzes, consisting of a case of glass or other suitable material, containing two insulated wires, the terminals of which are connected by a bridge of fine wire composed of a platinum alloy.

Low Tension Electric Fuzes, consisting of a case of glass or other suitable material, containing two insulated wires, the terminals of which are connected by a bridge of fine wire composed of a platinum alloy, the case being filled with a charge not exceeding twenty (20) grains of (*a*) gunpowder, or (*b*) carefully purified collodion cotton, or (*c*) carefully purified guncotton.

Low Tension Electric Fuzes, consisting of a case of glass or other suitable material, containing two insulated wires, the terminals of which are connected by a bridge of platinum wire, or other suitable material, embedded in a charge not exceeding 20 grains of (*a*) gunpowder, or (*b*) carefully purified collodion cotton, or (*c*) carefully purified guncotton, or (*d*) chlorate of potash and sulphide of antimony.

Spon's Electric Fuzes, consisting of a case of metal, wood, paper, or other suitable material, containing two or more insulated wires, the terminals of which are (*a*) embedded in a charge not exceeding five grains of one or the other of the priming compositions (1), (2), (3), herein-after specified; or (*b*) connected by a bridge of fine wire composed of a platinum alloy, steel, or other suitable material, the said bridge being embedded in a charge not exceeding 10 grains of one or other of the priming compositions (4), (5), herein-after mentioned:—

Priming composition (1).—Chlorate of potash and sulphide of antimony, with or without powdered carbon.

Priming composition (2).—Chlorate of potash, sulphide of antimony, and phosphide of copper.

Priming composition (3).—Chlorate of potash, sulphide of copper, and phosphide of copper.

Priming composition (4).—Guncotton thoroughly purified.

Priming composition (5).—Guncotton thoroughly purified, chlorate of potash, and powdered galls.

Electric Primers, consisting of a case of metal or other suitable material containing two or more insulated wires the terminals of which are connected by a thin bridge of platinum wire, or other suitable material, embedded in a charge not exceeding 15 grains of a priming composition consisting of gunpowder and thoroughly purified guncotton.

Abel's Electric Tubes, consisting of a case of wood or other suitable material containing two insulated wires, the terminals of which are (*a*) embedded in a charge not exceeding two grains of the priming composition, No. 1, consisting of sulphide of copper, phosphide of copper, and chlorate of potash, intimately mixed together, or (*b*) connected by a bridge of fine wire composed of a platinum alloy, steel or other suitable material, the said bridge being embedded in a charge not exceeding ten grains of the priming composition, No. 2, viz., consisting of gunpowder and thoroughly purified guncotton, the case being fitted to a small cylindrical tube of quill, metal, or paper, or other suitable material, charged with gunpowder and having a hollow up the centre of the same.

Elswick Electric Tubes, consisting of a case of metal, wood, paper, or other suitable material, containing (*a*) two or more insulated wires, the terminals of which are connected by a fine wire of platinum or other suitable material embedded in a charge not exceeding ten grains of guncotton thoroughly purified, and (*b*) a charge not exceeding one ounce of gunpowder; the said case being completely closed by means of a cork disc or other suitable material.

Fuzes for Shells, consisting of cases of wood, metal, or other suitable material, charged or primed with fuze or other suitable composition, not containing their own means of ignition, and of such strength and construction that the explosion of one fuze will not communicate the explosion to other like fuzes.

Fuzes for Shells, consisting of cases of wood, metal, or other suitable material, charged or primed with fuze or other suitable composition, and whether or not containing their own means of ignition, and of such strength and construction that the explosion of one fuze will not produce an explosion en masse of other like fuzes.

Gunpowder Fuzes, consisting of cases of metal, wood, or other suitable material, containing a charge of gunpowder not exceeding two drams in each fuze.

Guncotton Fuzes, consisting of cases of metal, wood, or other suitable material, containing a charge of thoroughly purified guncotton, not exceeding two drams in each fuze.

Instantaneous Fuze, consisting of a preparation of gunpowder, yarn, and a protective coating, which is not a safety fuze, and does not contain its own means of ignition.

Pain's Instantaneous Pyrotechnic Fuzes, consisting of a closed case of paper, wood, or other suitable material, having affixed therein by means of a plug of sulphur two insulated copper wires the terminals of which are connected by a bridge of fine wire consisting of platinum, platinum alloy, steel, or other suitable material, such bridge being embedded in a charge of gunpowder not exceeding 20 grains.

German Spills, consisting of cylindrical cases of paper, containing a charge of gunpowder not exceeding one pound (1 lb.) per gross, and primed at one end with touch paper, and at the other with mealed gunpowder, or primed at both ends with mealed gunpowder.

Miners' Squibs, consisting of a tube of paper or other suitable material partly filled with gunpowder in the proportion of not more than one pound (1 lb.) of gunpowder to every 500 squibs and having one end closed with a plug of wax or other suitable material, and the other end closed by being twisted, and such twisted end being coated with sulphur, or not so coated.

Bickford's Patent Volley Firers, consisting of a small cylinder of tin-plate, zinc, wood, cardboard, or other suitable material, into one end of which is placed a socket or block of wood, or other suitable material, with a hole through the centre, and with a disc, wad, or cap made of, containing, or saturated with, a priming paste of mealed powder at the base of the same; the said cylinder and socket or block being fitted with safety fuze or instantaneous fuze or not so fitted.

Tubes for firing Explosives, consisting of cases of quill, metal, or paper, charged with mealed powder or other suitable explosive, and not containing their own means of ignition.

War Rockets, consisting of cases of iron or other suitable material, containing rocket composition consisting of an intimate mixture of saltpetre, sulphur, and charcoal, and not containing their own means of ignition.

Division 3.

(*Containing its own means of ignition.*)

Cartridges for Small Arms (which are not Safety Cartridges). *O. in C., No.* 1.

Electric Detonators, consisting of a detonator having two insulated wires connected by a fine platinum wire embedded in a priming composition consisting of chlorate of potash and sulphide of antimony, or purified guncotton, and so placed and secured that no part of the wires can come into contact with the fulminate in such detonator.

Abel's Electric Detonator Fuzes, consisting of a case of wood or other suitable material, containing two insulated wires, the terminals of which are (*a*) embedded in a charge not exceeding

two grains of the priming composition No. 1, herein-after specified, or (*b*) connected by a bridge of fine wire composed of a platinum alloy, steel, or other suitable material, the said bridge being embedded in a charge not exceeding 10 grains of the priming material No. 2, herein-after specified, the case being fitted with a detonator :—

Priming composition No. 1, consisting of sulphide of copper, phosphide of copper, and chlorate of potash intimately mixed together.

Priming composition No. 2, consisting of gunpowder and thoroughly purified guncotton.

Bornhardt's Electric Detonator Fuzes, consisting of a detonator as defined by Order in Council made under 106th section of the Act, such detonator having inserted therein two insulated wires, the terminals of which are embedded in a priming composition composed of chlorate of potash and native sulphide of antimony, and the detonator being so constructed, and the wires so adjusted and secured that the terminals of the said wires cannot come into contact with the fulminate in the said detonators.

Brain's Electric Detonator Fuzes, consisting of Brain's Electric Fuzes as above described (*see* above in Division 2), and having attached thereto a detonator as defined by Order in Council made under the 106th section of the Explosives Act, 1875.

Electric Detonator Fuzes (Smith's Patent), consisting of electric fuzes as above described (*see* above in Division 2), and having attached thereto a detonator as defined by an Order in Council made under the 106th section of the said Act. Provided that no one such electric detonator fuze shall contain more than thirty (30) grains of explosive of the 5th (Fulminate) Class, as defined in the said Order.

High Tension Electric Detonator Fuzes, consisting of high tension electric fuzes as above described, and having attached thereto a detonator as defined by an Order in Council, made under the 106th section of the Explosives Act, 1875.

High Tension Electric Detonator Fuzes (Brain's Patent), consisting of high tension electric fuzes as above described, and having attached thereto a detonator as defined by an Order in Council, made under the 106th section of the Explosives Act, 1875.

High Tension Electric Detonator Fuzes, consisting of high tension electric fuzes (*see* above in Division 2) and having attached thereto a detonator.

Low Tension Electric Detonator Fuzes, consisting of low tension electric fuzes, as above described, and having attached thereto a detonator as defined by an Order in Council, made under the 106th section of the Explosives Act, 1875.

Low Tension Electric Detonator Fuzes, consisting of low tension electric fuzes as above described (*see* above in Division 2), and having the platinum wire embedded in a charge not exceeding two (2) grains of a priming composition consisting of (*a*) carefully purified guncotton or (*b*) carefully purified collodion cotton and the case being fitted with a detonator.

Low Tension Electric Detonator Fuzes, consisting of a low tension electric fuze as above described (*see* above in Division 2), and having attached thereto a detonator.

Spon's Electric Detonator Fuzes, consisting of Spon's Electric Fuzes as above described (*see* above in Division 2), and having attached thereto a detonator as defined by an Order in Council made under the 106th section of the Act.

Fuzes for Shell, consisting of cases of wood or metal, or other suitable material, charged or primed with fuze or other suitable composition, containing their own means of ignition, and of such strength and construction that the explosion of one fuze will not communicate the explosion to other like fuzes.

Colliery Safety Lighters, consisting of a tube of metal, millboard, or other suitable material, closed at one end, and containing sulphuric acid enclosed in a glass globule or tube embedded in or contiguous to a mixture of chlorate of potassium and sugar (whether or not contained in an inner metallic tube, containing or not containing gunpowder), and with or without the addition of a piece of safety-fuze. Provided that the amount of the mixture aforesaid contained in any one of the said colliery safety lighters shall not exceed five (5) grains. Provided also that the said colliery safety lighters shall be of such strength and construction that the ignition of one such colliery safety lighter will not communicate laterally with others.

Detonators, consisting of a capsule or case of such strength and construction, and containing an explosive of the fulminate class in such quantity that the explosion of one capsule or case will communicate the explosion to other like capsules or cases. *O. in C., No.* 1.

Tubes for Firing Explosives, (other than to Detonators) consisting of cases of quill, metal, or paper, charged with mealed powder or other suitable explosive, and containing their own means of ignition.

Elswick Mechanical Tubes, consisting of a case of metal, wood, paper, or other suitable material, containing its own means of ignition and a charge not exceeding one ounce of gunpowder.

Safety Firing Tubes, No. 2, consisting of Safety Firing Tubes, No. 1 (*see* above in Division 1), with the addition of a priming charge of meal powder not exceeding 40 grains. The whole to be of such construction that the explosion of one will not communicate to others in close contact.

Class 7.—Fireworks.

Division 1.

Firework Composition, consisting of any chemical compound or mechanically mixed preparation of an explosive or inflammable nature which is used for the purpose of making manufactured fireworks, and is not included in the former classes of explosives, and also any coloured fire composition. *O. in C., No.* 1.

Division 2.

Amorces (whether in the form of toy caps or igniting tapes), consisting of dots of one or other of the undermentioned compositions enclosed between two pieces of paper, or separated by a sheet of paper or cardboard, in a proportion not exceeding seventy (70) grains of such composition to every one thousand (1,000) dots.

Composition (*a*): A mixture of chlorate of potassium and amorphous phosphorous, with or without the addition of (1) nitrate of potassium, sulphide of antimony and powdered sulphur (free from acid), or (2) chalk, rye, flour, and resin (sandarak), or (3) manganese and glue; or (4) such other substance as may from time to time be approved by the Secretary of State; provided that the amount of amorphous phosphorous present in the mixture shall in no case exceed the proportion of ten (10) grains in one thousand (1,000) dots.

Composition (*b*): A mixture of chlorate of potassium and ferrocyanide of lead.

Crack Shots, consisting of an amorce composed of a patch of thoroughly purified fulminate of silver enclosed between two pieces of paper in a proportion not exceeding fifteen (15) grains of such fulminate of silver to every one thousand (1,000) amorces, such amorce to be gummed to or form part of a sheet of paper not less than four (4) inches square, and having a strip impregnated with nitre.

Manufactured Fireworks, consisting of any explosive of the foregoing classes, and any firework composition, when such explosive or composition is enclosed in any case or contrivance, or is otherwise manufactured so as to form a squib, cracker, serpent, rocket (other than a war rocket), maroon, star, lance, wheel Chinese fire, Roman candle, or other article adapted for the production of pyrotechnic effects or pyrotechnic signals. *O. in C., No.* 1.

Oriental Fireworks, consisting of a mixture of saltpetre, sulphur, and charcoal, enclosed in a paper or bamboo case, with or without the addition of a mixture of realgar and chlorate of potash: provided that the amount of such mixture of realgar and chlorate of potash shall not exceed two (2) grains in any one firework.

Socket Sound Signals, consisting of a case of tinned iron, containing one or more charges of tonite or cotton powder as herein-after described, such charges not exceeding together eight (8) ounces, and having inside the base of the said case, or attached to the exterior thereof in a case or bag of india rubber, canvas, or other suitable material, a charge of gunpowder not exceeding two and a half ($2\frac{1}{2}$) ounces; the charges of tonite and gunpowder being connected by means of a suitable time fuze of wood, copper, or tinned iron, in communication or connexion with a detonator as defined by an Order in Council made under the 106th section of the said Act, such detonator to contain above the fulminate a substantial layer of strongly compressed mealed gunpowder, and being itself embedded in tonite, the said tonite to consist of guncotton thoroughly purified, mixed or impregnated with a nitrate or nitrates.

Socket Distress Signals, consisting of a socket sound signal as above described, in the upper part thereof a star or stars composed of two or more of the following ingredients, viz., saltpetre, sulphur (carefully washed), realgar, antimony, gunpowder; or one or more stars of the following composition, viz., *Red Stars*, consisting of nitrate of strontia, chlorate of potash, charcoal, and shellac, incorporated with shellac solution, and with or without the addition of guncotton thoroughly purified, not exceeding 10 per cent. by weight of the finished stars. *Green Stars*, consisting of nitrate of baryta, chlorate of potash, charcoal, and shellac incorporated with shellac solution, and with or without the addition of guncotton thoroughly purified, not exceeding 10 per cent. by weight of the finished stars. *White Stars*, consisting of nitrate of potash, sulphur (carefully washed), sulphide of antimony, realgar, gunpowder, and magnesium, incorporated with shellac solution, and with or without the addition of guncotton, thoroughly purified, not exceeding 10 per cent. by weight of the finished stars Provided that each star may have a strand not exceeding five (5) grains in weight of thoroughly purified nitro-cellulose attached to and passing through it.

Sound Signal Rockets, consisting of a signal rocket, having fitted in the head thereof one or more charges of tonite or cotton powder as herein-after described, and with or without a layer of compressed gunpowder made of sulphur free from acid, saltpetre, and charcoal between the said charges, and having embedded in the said charges one or more detonators as defined by an Order in Council made under the 106th section of the said Act, such detonators to contain above the fulminate a substantial layer either of strongly compressed mealed gunpowder, or of a composition made of two or more of the following ingredients, viz., saltpetre, sulphur (carefully washed), realgar, antimony, gunpowder; the said tonite to consist of guncotton thoroughly purified, mixed or impregnated with a nitrate or nitrates.

Socket Light Signals, consisting of a case of tin or other suitable material, containing one or more white or coloured stars of the compositions herein-after specified, and having attached to the base of the said case in a case or bag of india-rubber, canvas, or other suitable material, a charge of gunpowder not exceeding 2½ ozs., the said stars and gunpowder being connected by means of a suitable time fuze of wood, copper, tinned iron, or other suitable material. Provided that the total weight of the star or stars contained in any one signal shall not exceed 8 ozs. *Red Stars,* consisting of nitrate of strontia, chlorate of potash, charcoal, and shellac, incorporated with shellac solution, with or without the addition of guncotton thoroughly purified, not exceeding 10 per cent. by weight of the finished stars. *Green Stars,* consisting of nitrate of baryta, chlorate of potash, charcoal, and shellac incorporated with shellac solution, with or without the addition of guncotton thoroughly purified, not exceeding 10 per cent. by weight of the finished stars. *White Stars,* consisting of nitrate of potash, sulphur (carefully washed), sulphide of antimony, realgar, gunpowder, and magnesium incorporated with shellac solution, with or without the addition of guncotton thoroughly purified, not exceeding 10 per cent. by weight of the finished stars. Provided that each star may have a strand not exceeding five (5) grains in weight of thoroughly purified nitro-cellulose attached to or passing through it.

Distress Signal Rockets, consisting of sound signal rockets as above described (*see* Class 6, Division 3), with the addition in the head of the rocket of one or more stars composed of two or more of the following ingredients, viz., saltpetre, sulphur (carefully washed), realgar, antimony, gunpowder.

Throwdowns.
Snaps for Bonbon Crackers. } Licensed as "Toy Fireworks."

Magic Candle Pin Crackers, consisting of thoroughly purified fulminate of silver, gummed, or otherwise attached to a pin, and protected by a coating of paper, in a proportion not exceeding fifteen (15) grains of such fulminate of silver to every one thousand (1,000) magic candle pin crackers.

N.B.—*It is a condition of the license that these crackers shall be packed in numbers not exceeding twelve in stout paper, and each such package placed singly in a box of wood or cardboard, properly secured against escape of explosive; such boxes to be further packed as required for fireworks.*

APPENDIX E (1).

Distribution in Counties of Factories, Magazines, and Toy Firework Factories.

Counties.	Factories.			Magazines.			Toy Firework Factories.
	Under Continuing Certificate.	Under License.	Total.	Under Continuing Certificate.	Under License.	Total.	
ENGLAND AND WALES.							
Anglesey	—	—	—	1	1	2	—
Bedford	—	—	—	—	—	—	—
Berks	—	—	—	—	—	—	—
Brecon	—	—	—	—	—	—	—
Buckingham	—	—	—	—	—	—	—
Cambridge	—	—	—	—	—	—	—
Cardigan	—	—	—	3	1	4	—
Carmarthen	—	1	1	1	2	3	—
Carnarvon	—	—	—	4	11	15	—
Chester	—	—	—	3	6*	9	—
Cornwall	4	9	13	6	17	23	—
Cumberland	—	2	2	2	18	20	—
Denbigh	—	1	1	1	5	6	—
Derby	1	2	3	5	2	7	—
Devon	1	—	1	5	3	8	—
Dorset	—	—	—	—	—	—	—
Durham	—	2	2	10	8	18	—
Carried forward	6	17	23	41	74	115	—

* Including the three floating magazines in the River Mersey, which are under special legislation.

Counties.	Factories.			Magazines.			Toy Firework Factories.
	Under Continuing Certificate.	Under License.	Total.	Under Continuing Certificate.	Under License.	Total.	
ENGLAND AND WALES—*cont.*							
Brought forward	6	17	23	41	74	115	—
Essex	—	5	5	7	11	18	—
Flint	—	—	—	2	1	3	—
Glamorgan	1	2	3	4	11	15	—
Gloucester	—	2	2	4	3	7	—
Hants	1	—	1	—	—	—	—
Hereford	—	—	—	—	—	—	—
Hertford	—	1	1	—	—	—	—
Huntingdon	—	—	—	—	—	—	—
Kent	7	9	16	2	12	14	—
Lancaster	4	5	9	9	12	21	1
Leicester	—	1	1	1	2	3	—
Lincoln	—	—	—	—	—	—	—
Merioneth	1	1	2	6	11	17	—
Middlesex	2	5	7	1	—	1	9
Monmouth	—	1	1	7	1	8	—
Montgomery	—	—	—	2	1	3	—
Norfolk	—	—	—	—	—	—	—
Northampton	—	—	—	—	—	—	—
Northumberland	—	4	4	8	7	15	—
Nottingham	—	2	2	1	6	7	—
Oxford	—	—	—	—	—	—	—
Pembroke	—	—	—	2	2	4	—
Radnor	—	—	—	—	—	—	—
Rutland	—	—	—	—	—	—	—
Salop	—	—	—	1	4	5	—
Somerset	—	—	—	1	3	4	—
Stafford	2	2	4	16	6	22	—
Suffolk	1	1	2	—	—	—	—
Surrey	1	5	6	—	—	—	1
Sussex	—	—	—	—	—	—	—
Warwick	1	3	4	1	1	2	—
Westmoreland	4	—	4	—	—	—	—
Wilts	—	—	—	—	—	—	—
Worcester	2	4	6	1	—	1	—
York	4	2	6	12	24	36	—
Totals	37	72	109	129	192	321	11
SCOTLAND.							
Aberdeen	—	—	—	—	4	4	—
Argyll	1	1	2	—	4	4	—
Ayr	1	3	4	1	2	3	—
Banff	—	—	—	1	1	2	—
Berwick	—	—	—	—	—	—	—
Bute	—	—	—	—	—	—	—
Caithness	—	—	—	—	—	—	—
Clackmannan	—	—	—	—	1	1	—
Cromarty	—	—	—	—	—	—	—
Carried forward	2	4	6	2	12	14	—

Counties.	Factories.			Magazines.			Toy Firework Factories.
	Under Continuing Certificate.	Under License.	Total.	Under Continuing Certificate.	Under License.	Total.	
SCOTLAND—*cont.*							
Brought forward	2	4	6	2	12	14	—
Dumbarton	—	—	—	—	—	—	—
Dumfries	—	—	—	—	—	—	—
Edinburgh	1	4	5	3	1	4	—
Elgin	—	—	—	—	—	—	—
Fife	—	1	1	2	4	6	—
Forfar	—	—	—	—	3	3	—
Haddington	—	—	—	—	—	—	—
Inverness	—	—	—	—	1	1	—
Kincardine	—	—	—	—	—	—	—
Kinross	—	—	—	—	—	—	—
Kirkcudbright	—	—	—	—	—	—	—
Lanark	—	1	1	2	4	6	—
Linlithgow	—	—	—	—	3	3	—
Nairn	—	—	—	—	—	—	—
Orkney and Shetland	—	—	—	—	—	—	—
Peebles	—	—	—	—	—	—	—
Perth	—	—	—	—	1	1	—
Renfrew	—	—	—	1	2	3	—
Ross	—	—	—	—	—	—	—
Roxburgh	—	—	—	—	—	—	—
Selkirk	—	—	—	—	—	—	—
Stirling	1	1	2	1	3	4	—
Sutherland	—	—	—	—	—	—	—
Wigton	—	—	—	—	—	—	—
Totals	4	11	15	11	34	45	—
IRELAND.							
Antrim	—	—	—	—	3	3	—
Armagh	—	—	—	—	—	—	—
Carlow	—	—	—	—	—	—	—
Cavan	—	—	—	—	—	—	—
Clare	—	—	—	—	—	—	—
Cork	1	—	1	—	1	1	—
Donegal	—	—	—	—	—	—	—
Down	—	1	1	1	—	1	—
Dublin	—	1	1	—	7	7	—
Fermanagh	—	—	—	—	—	—	—
Galway	—	—	—	1	—	1	—
Kerry	—	—	—	—	—	—	—
Kildare	—	—	—	—	—	—	—
Kilkenny	—	—	—	—	—	—	—
King's County	—	—	—	—	—	—	—
Leitrim	—	—	—	—	—	—	—
Limerick	—	—	—	—	1	1	—
Londonderry	—	—	—	—	1	1	—
Longford	—	—	—	—	—	—	—
Louth	—	—	—	—	—	—	—
Totals	1	2	3	2	13	15	—

Counties.	Factories.			Magazines.			Toy Firework Factories.
	Under Continuing Certificate.	Under License.	Total.	Under Continuing Certificate.	Under License.	Total.	
IRELAND—*cont.*							
Brought forward -	1	2	3	2	13	15	—
Mayo - - - -	—	—	—	—	—	—	—
Meath - - - -	—	—	—	—	—	—	—
Monaghan - - - -	—	—	—	—	—	—	—
Queen's County - - -	—	—	—	—	—	—	—
Roscommon - - -	—	—	—	—	—	—	—
Sligo - - - -	—	—	—	—	—	—	—
Tipperary - - - -	—	—	—	—	—	—	—
Tyrone - - - -	—	—	—	—	—	—	—
Waterford - - - -	—	—	—	—	—	—	—
Westmeath - - -	—	—	—	—	—	—	—
Wexford - - - -	—	—	—	—	—	—	—
Wicklow - - -	—	—	—	—	—	—	—
Totals - - -	1	2	3	2	13	15	—
SUMMARY.							
ENGLAND AND WALES - - -	37	72	109	129	192	321	11
SCOTLAND - - - -	4	11	15	11	34	45	—
IRELAND - - - -	1	2	3	2	13	15	—
Grand Totals - -	42	85	127	142	239	381	11

APPENDIX E (2).

DISTRIBUTION in COUNTIES of STORES, SMALL FIREWORK FACTORIES, and REGISTERED PREMISES.

Counties.	Stores.			Small Firework Factories.	Registered Premises.	Remarks.
	Under Continuing Certificate.	Under License.	Total.			
ENGLAND AND WALES.						
Anglesey - - -	—	2	2	—	17	
Bedford - - -	—	2	2	—	65	
Berks - - -	—	—	—	—	112	
Brecon - - -	—	11	11	—	37	
Buckingham - - -	—	—	—	—	88	
Cambridge - - -	—	—	—	1	38	
Cardigan - - -	—	21	21	—	20	
Carmarthen - -	—	13	13	—	125	
Carried forward -	—	49	49	1	502	

Counties.	Stores.			Small Firework Factories.	Registered Premises.	Remarks.
	Under Continuing Certificate.	Under License.	Total.			
ENGLAND—*cont.*						
Brought forward -	—	49	49	1	502	
Carnarvon - - -	6	46	52	—	53	
Chester - - -	—	29	29	—	492	
Cornwall - - -	25	91	116	—	191	
Cumberland - - -	8	95	103	—	131	
Denbigh - - -	1	28	29	—	56	
Derby - - -	2	94	96	—	576	
Devon - - -	—	46	46	2	445	
Dorset - - -	—	2	2	—	34	
Durham - - -	8	114	122	—	1,017	
Essex - - -	—	1	1	2	590	
Flint - - -	2	38	40	—	42	
Glamorgan - - -	—	85	85	—	425	
Gloucester - - -	—	21	21	3	514	
Hants - - -	—	5	5	—	294	
Hereford - - -	—	2	2	—	65	
Hertford - - -	1	—	1	—	94	
Huntingdon - - -	1	—	1	—	37	
Isle of Wight - - -	—	—	—	—	40	
Kent - - - -	—	3	3	—	446	
Lancaster - - -	43	149	192	1	4,507	
Leicester - - -	11	19	30	—	210	
Lincoln - - -	—	10	10	1	365	
London - - -	—	1	1	3	3,420	
Merioneth - - -	—	31	31	—	24	
Middlesex - - -	—	—	—	—	344	
Monmouth - - -	—	22	22	—	329	
Montgomery - - -	—	9	9	—	82	
Norfolk - - -	—	6	6	—	344	
Northampton - - -	—	3	3	—	136	
Northumberland - -	19	79	98	—	342	
Nottingham - - -	—	25	25	—	366	
Oxford - - -	—	3	3	—	90	
Pembroke - - -	—	5	5	—	42	
Radnor - - -	—	1	1	—	—	
Rutland - - -	—	—	—	—	11	
Salop - - -	9	25	34	—	142	
Somerset - - -	—	19	19	—	273	
Stafford - - -	24	120	144	1	706	
Suffolk - - -	—	2	2	—	258	
Surrey - - -	—	3	3	—	366	
Sussex - - -	—	2	2	1	539	
Warwick - - -	4	23	27	2	1,092	
Westmorland - - -	—	18	18	—	61	
Wilts - - -	—	—	—	—	54	
Worcester - - -	—	10	10	—	230	
York - N.R. - -	14	19	33	—	362	
York - E.R. - -	—	—	—	—	261	
York - W.R. - -	6	161	167	2	3,846	
Totals - -	184	1,514	1,698	19	24,846	

Counties.	Stores.			Small Firework Factories.	Registered Premises.	Remarks.
	Under Continuing Certificate.	Under License.	Total.			
SCOTLAND.						
Aberdeen	—	32	32	—	162	
Argyl	4	17	21	—	16	
Ayr	4	49	53	—	253	
Banff	—	7	7	—	32	
Berwick	—	3	3	—	23	
Bute	—	—	—	—	5	
Caithness	—	—	—	—	18	
Clackmannan	—	4	4	—	22	
Cromarty	—	—	—	—	—	
Dumbarton	2	18	20	—	16	
Dumfries	—	11	11	—	36	
Edinburgh	2	24	26	—	483	
Elgin	—	2	2	—	24	
Fife	2	42	44	—	143	
Forfar	—	2	2	—	211	
Haddington	—	4	4	—	12	
Inverness	—	4	4	—	57	
Kincardine	—	3	3	—	45	
Kinross	—	—	—	—	10	
Kirkcudbright	—	5	5	—	10	
Lanark	4	103	107	—	308	
Linlithgow	—	20	20	—	64	
Nairn	—	—	—	—	2	
Orkney	—	—	—	—	18	
Shetland	1	1	2	—	12	
Peebles	—	—	—	—	7	
Perth	—	10	10	—	58	
Renfrew	—	11	11	—	65	
Ross	—	1	1	—	31	
Roxburgh	—	1	1	—	34	
Selkirk	—	—	—	—	3	
Stirling	—	24	24	—	73	
Sutherland	—	—	—	—	12	
Wigtown	—	—	—	—	22	
Totals	19	398	417	—	2,287	
IRELAND.						
Antrim	2	21	23	—	170	
Armagh	—	—	—	—	51	
Carlow	—	2	2	—	12	
Cavan	—	—	—	—	14	
Clare	—	—	—	—	19	
Cork	—	8	8	—	33	
Carried forward	2	31	33	—	299	

Counties.	Stores.			Small Firework Factories.	Registered Premises.	Remarks.
	Under Continuing Certificate.	Under License.	Total.			
IRELAND—*cont.*						
Brought forward -	2	31	33	—	299	
Donegal - - -	—	6	6	—	27	
Down - - -	—	—	—	—	76	
Dublin - - -	—	—	—	—	27	
Fermanagh - - -	—	2	2	—	14	
Galway - - -	—	4	4	—	20	
Kerry - - -	—	4	4	—	11	
Kildare - - -	—	—	—	—	11	
Kilkenny - - -	—	—	—	—	13	
King's County - -	—	—	—	—	16	
Leitrim - - -	—	—	—	—	7	
Limerick - - -	—	3	3	—	22	
Londonderry - - -	—	2	2	—	65	
Longford - - -	—	—	—	—	6	
Louth - -	—	—	—	—	10	
Mayo - - - -	—	2	2	—	18	
Meath - - -	—	—	—	—	11	
Monaghan - - -	—	1	1	—	18	
Queen's County - -	—	2	2	—	10	
Roscommon - - -	—	3	3	—	10	
Sligo - - -	—	—	—	—	6	
Tipperary - - -	—	4	4	—	29	
Tyrone - - -	—	2	2	—	55	
Waterford - - -	—	—	—	—	6	
Westmeath - - -	—	1	1	—	18	
Wexford - - -	—	4	4	—	16	
Wicklow - - -	—	—	—	—	12	
Totals - -	2	71	73	—	833	
SUMMARY.						
ENGLAND AND WALES - -	184	1,514	1,698	19	24,846	
SCOTLAND - - -	19	398	417	—	2,287	
IRELAND - - - -	2	71	73	—	833	
GRAND TOTALS -	205	1,983	2,188	19	27,966	

APPENDIX F.

Order of Secretary of State, No. 3 (c).

Explosives Act, 1875, 38 *Vict. c.* 17.

Whereas in pursuance of the Explosives Act, 1875 (in this Order referred to as the Act), an Order of the Secretary of State (known as Order of Secretary of State, No. 3) was made on the 27th day of November 1875, adapting the General Rules relating to packing of gunpowder contained in Part I. of the Act, to the packing of explosives other than Gunpowder; and whereas by section 83 of the Act, it is provided that a Secretary of State may by order from time to time revoke, add to, or alter any previous orders of the Secretary of State.

Now, therefore, in the exercise of the powers aforesaid, I, one of Her Majesty's Principal Secretaries of State, hereby order as follows:—

1. Part B., Rule 2, of the Order of the Secretary of State, No. 3, aforesaid, relating to the packing of explosives of the 1st division of the 3rd (nitro-compound) class, shall be amended as follows:—

(*a.*) By the insertion after the words "without any metal in the construction thereof" in the said Rule, of the words "except with the consent of, and under conditions approved by a "Government Inspector"; and

(*b.*) By the insertion after the words "other than metal" in the said Rule of the words "except "with the consent of, and under conditions approved by a Government Inspector."

(Signed) H. H. Asquith,
One of Her Majesty's Principal
Secretaries of State.

Whitehall, 30th October 1893.

APPENDIX G.

List of Railways (including Docks working under the Railway Code) the Byelaws of which have been confirmed, and of those Railways, &c. which refuse to carry Explosives, corrected up to 31st December 1893.

Byelaws. Whether Model Code, &c.	Name of Railway or Dock.	Date of Sanction of Byelaws.		Explosives not carried.		Remarks.
		Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	
	ENGLAND AND WALES.					
M. C.	Barry Railway	9/10/91	—	—	—	
M. C.	Bishop's Castle	14/12/76	—	—	—	
M. C.	Brecon and Merthyr Tydvil Junction	30/10/76	—	—	—	
M. C.	Cambrian, including:—	22/3/83	—	—	—	
—	Mid Wales	27/10/76	—	—	—	
M. C.	Central Wales and Carmarthen Junction.	—	—	—	—	Railway transferred to London and North Western Railway Company.
Special	Chelsea Dock	—	—	—	—	*See* West London Extension Railway.
M. C.	Cheshire Lines Committee	21/10/76	—	—	—	
M. C.	Cleator and Workington Junction	22/3/79	—	—	—	
M. C.	Cockermouth, Keswick, and Penrith	18/11/76	—	—	—	Joint property of Midland, Great Northern, and Manchester, Sheffield, and Lincolnshire Railway Companies.
M. C.	Colne Valley	—	—	—	—	(*See* Great Eastern).
M. C.	Cornwall	—	—	—	—	Amalgamated with Great Western.
M. C.	Cowes and Newport	—	—	—	—	Now Isle of Wight Central.
M. C.	Denbigh, Ruthin, and Corwen	—	—	—	—	Railway transferred to London and North Western Railway Company.
M. C.	East and West Junction	4/12/76	—	—	—	
M. C.	Eastern and Midlands	—	—	—	—	Now worked by Midland and Great Northern Joint Committee.
M. C.	Felixstowe Railway and Pier	—	—	—	—	Now Great Eastern.
M. C.	Festiniog	10/1/77	—	—	—	
M. C.	Festiniog and Blaenau	—	—	—	—	Now Great Western.
M. C.	Furness	3/7/91	—	—	—	
Special as to Byelaw 10.	Carried forward	11	—	—	—	

Byelaws. Whether Model Code, &c.	Name of Railway or Dock.	Date of Sanction of Byelaws.		Explosives not carried.		Remarks.
		Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	
	ENGLAND AND WALES—*continued.*					
	Brought forward - -	11	—	—	—	
Special	Foss River - - -	—	—	—	—	*See* Canals.
M. C.	Great Eastern, including :— -	7/12/76	—	—	—	
	Colne Valley - - -	7/12/76	—	—	—	
M. C.	Felixstowe Railway and Pier -	16/1/79	—	—	—	
M. C.	Thetford and Watton - -	4/10/76	—	—	—	
M. C.	Great Northern, including :— -	27/10/76	—	—	—	
	Stafford and Uttoxeter - -	—	—	1	—	
M. C.	Great Northern and Great Eastern Joint Committee.	10/3/82	—	—	—	
M. C.	Great Northern and London and North-Western Joint Committee.	8/9/79	—	—	—	
M. C.	Great Western, including :— -	18/1/77	—	—	—	
M. C.	Cornwall - - -	26/1/80	—	—	—	
M. C.	Blaenau and Festiniog - -	—	—	1	—	
M. C.	Monmouthshire - -	7/11/76	—	—	—	
M. C.	Torbay and Brixham - -	27/11/76	—	—	—	
Special	Grimsby Docks - - - -	—	—	—	—	*See* Manchester, Sheffield, and Lincolnshire Railway.
Special	Hartlepool Docks - -	—	—	—	—	Property of North-Eastern Railway Company.
M. C.	Hoylake and Birkenhead - -	—	—	—	—	Merged into Wirral Railway.
M. C.	Hull, Barnsley, and West Riding Junction Railway and Dock.	4/6/85	—	—	—	
M. C.	Isle of Wight - - -	7/6/77	—	—	—	
—	Isle of Wight Central, including :—	—	—	—	—	
—	Cowes and Newport - -	7/3/77	—	—	—	
—	Ryde and Newport - -	9/2/77	—	—	—	
—	Lancashire and Yorkshire -	—	—	1	—	
M. C.	Liskeard and Caradon - -	1/8/79	—	—	—	
M. C.	London and North-Western, including :—	30/10/76	—	—	—	
M. C.	Central Wales and Carmarthen Junction.	25/10/76	—	—	—	
M. C.	Denbigh, Ruthin, and Corwen	25/1/77	—	—	—	
M. C.	London and North-Western and Rhymney Joint.	11/12/76	—	—	—	
M. C.	London and North-Western and Furness Joint, including :—	12/8/78	—	—	—	
M. C.	Whitehaven, Cleator, and Egremont.	12/10/76	—	—	—	
M. C.	London and North-Western and Midland Joint (Ashby and Nuneaton).	9/12/76	—	—	—	
M. C.	London and North-Western and Brecon and Merthyr Joint Committee.	1/9/79	—	—	—	
M. C.	London and North-Western and Great Western Joint.	27/1/77	—	—	—	
M. C.	London, Brighton, and South Coast	14/12/76	—	—	—	
M. C.	London, Chatham, and Dover -	6/2/77	—	—	—	
M. C.	London and South-Western -	30/10/76	—	—	—	
M. C.	London and St. Katherine Docks -	9/9/80	—	—	—	
M. C.	London, Tilbury, and Southend -	9/2/77	—	—	—	
M. C.	Londonderry (Seaham to Sunderland).	2/5/77	—	—	—	
M. C.	Macclesfield Committee - -	21/10/76	—	—	—	
M. C.	Manchester, Sheffield, and Lincolnshire, including :—	30/10/76	—	—	—	
M. C.	Trent, Ancholme, and Grimsby	7/12/76	—	—	—	
Special	Grimsby Docks - -	—	—	1	—	
—	Manchester, South Junction and Altrincham.	—	—	1	—	
M. C.	Manchester and Milford - -	17/1/77	—	—	—	
M. C.	Maryport and Carlisle - -	10/11/76	—	—	—	
M. C.	Mawddy - - -	13/4/77	—	—	—	
—	Metropolitan - - -	—	—	1	—	
—	Metropolitan District - -	—	—	1	—	
M. C.	Midland - - - -	8/12/76	—	—	—	
	Carried forward - -	49	—	7	—	

Byelaws. Whether Model Code, &c.	Name of Railway or Dock.	Date of Sanction of Byelaws.		Explosives not carried.		Remarks.
		Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	
	ENGLAND AND WALES—*continued.*					
	Brought forward - -	49	—	7	—	
—	Midland and Great Northern Joint Committee, including :—	—	—	—	—	
M. C.	Eastern and Midlands -	19/6/83	—	—	—	
—	Midland and South-Western Junction, including :—	—	—	—	—	
M. C.	Swindon, Marlboro', and Andover.	11/7/81	—	—	—	
M. C.	Mid-Wales - - -	—	—	—	—	*See* Cambrian.
Special	Millwall Docks - - -	—	—	1	—	
M. C.	Monmouthshire - - -	—	—	—	—	Now Great Western.
Special	Middlesboro' Docks - -	—	—	—	—	Now North-Eastern.
M. C.	Neath and Brecon - -	24/10/76	—	—	—	
M. C.	North-Eastern, including :— -	13/10/76	—	—	—	
Special	Middlesboro' Docks - -	—	—	1	—	
M. C.	Scotswood, Newburn, and Wylam	20/1/77	—	—	—	
Special	Tyne Dock - - - -	—	—	1	—	
Special	Hartlepool Docks - -	—	—	1	—	
Special	West Hartlepool Dock - -	—	—	1	—	
Special	Wearmouth Dock - - -	—	—	1	—	
—	North London - -	—	—	1	—	
M. C.	North Staffordshire - -	20/9/76	—	—	—	
M. C.	Northampton and Banbury Junction	13/2/77	—	—	—	
M. C.	Oldham, Ashton-under-Lyne, and Guide Bridge Junction.	21/10/76	—	—	—	
M. C.	Pembroke and Tenby - -	17/1/77	—	—	—	
M. C.	Penarth (Harbour and Dock) -	3/10/82	—	—	—	Lessees, Taff Railway Company.
M. C.	Potteries, Shrewsbury, and North Wales.	1/1/77	—	—	—	(Railway closed, to be acquired by Shropshire Railway Company; new undertaking.)
—	Preston and Wyre (London and North-Western and Lancashire and Yorkshire Joint).	—	—	1	—	
M. C.	Rhondda and Swansea Bay -	10/2/85	—	—	—	
M. C.	Rhymney - - -	6/10/76	—	—	—	
M. C.	Ryde and Newport - -	—	—	—	—	*See* Isle of Wight Central.
M. C.	Stafford and Uttoxeter - -	—	—	—	—	*See* Great Northern.
M. C.	Sheffield and Midland Companies Joint Committee.	7/12/76	—	—	—	
M. C.	Scotswood, Newburn, and Wylam -	—	—	—	—	*See* North-Eastern.
M. C.	Severn and Wye - -	17/6/78	—	—	—	Amalgamated with Severn Bdg.
M. C.	South-Eastern - - -	28/2/77	—	—	—	
M. C.	Southport and Cheshire Lines Extn.	26/6/84	—	—	—	
M. C.	Swindon, Marlboro', and Andover -	—	—	—	—	*See* Midland and South-Western Junction.
M. C.	Taff Vale - - -	30/9/76	—	—	—	
M. C.	Tallylyn - - -	20/1/77	—	—	—	
M. C.	Thetford and Watton - -	—	—	—	—	*See* Great Eastern.
M. C.	Torbay and Brixham - -	—	—	—	—	*See* Great Western.
M. C.	Trent, Ancholme, and Grimsby -	—	—	—	—	*See* Manchester, Sheffield, and Lincolnshire Railway.
Special	Tyne Dock - - - -	—	—	—	—	*See* North-Eastern Railway.
M. C.	Vale of Towy Joint Railway -	27/1/92	—	—	—	London and North-Western and Great Western.
M. C.	Van - - - - -	3/3/77	—	—	—	
M. C.	West London Extension, including :—	8/12/76	—	—	—	Property of London and North-Western, Great Western, London, Brighton, and South Coast, and London and South-Western Railway Companies.
	Chelsea Dock - - -	—	—	1	—	
Special	West Hartlepool Dock - -	—	—	—	—	*See* North-Eastern Railway.
M. C.	West Somerset (Mineral) - -	8/12/76	—	—	—	
M. C.	Whitehaven, Cleator, and Egremont	—	—	—	—	*See* London and North-Western and Furness Joint.
M. C.	Wrexham, Mold, and Connah's Quay.	5/11/87	—	—	—	
M. C.	Wirral Railway, including - -	6/12 80	—	—	—	
—	Hoylake and Birkenhead -	6/12/80	—	—	—	
	Total - - -	75	—	16	—	

RAILWAYS (including DOCKS working under the Railway Code) the BYELAWS of which have been confirmed, and of those Railways, &c. which refuse to carry Explosives, up to 31st December 1893.

Byelaws. Whether Model Code, &c.	Name of Railway or Dock.	Date of Sanction of Byelaws.		Explosives not carried.		Remarks.
		Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	
	SCOTLAND.					
—	Ayrton and Wigtonshire	—	—	—	—	(*See* Glasgow and South-Western).
M. C.	Anstruther and St. Andrews	9/7/84	—	—	—	
M. C.	Caledonian	30/10/76	—	—	—	
M. C.	City of Glasgow Union	30/10/76	—	—	—	
M. C.	Dundee and Arbroath Joint Committee.	17/10/81	—	—	—	
M. C.	Girvan and Portpatrick	20/8/77	—	—	—	
M. C.	Glasgow and South-Western	30/10/76	—	—	—	
M. C.	Glasgow, Barrhead, and Kilmarnock Joint.	30/10/76	—	—	—	
M. C.	Glasgow and Paisley Joint	30/10/76	—	—	—	Worked by North British.
M. C.	Glasgow, Yoker, and Clydebank	12/5/84	—	—	—	
M. C.	Great North of Scotland	4/10/76	—	—	—	
M. C.	Glasgow City and District	8/1/86	—	—	—	
M. C.	Highland	22/1/77	—	—	—	
M. C.	Kelvin Valley	—	—	—	—	*See* North British.
M. C.	Killin	25/3/92	—	—	—	
M. C.	Kilsyth and Bonnybridge	22/9/88	—	—	—	
M. C.	North British, including :—	30/10/76	—	—	—	
M. C.	Kelvin Valley	16/8/84	—	—	—	
M. C.	Strathendrick and Aberfoyle	27/6/84	—	—		
M. C.	Portpatrick and Wigtownshire Joint Committee, including :—	12/8/86	—	—	—	
	Wigtownshire	20/1/77	—	—	—	
	Total	19	—	—	—	
	IRELAND.					
M. C.	Ballycastle	6/8/80	—	—	—	
M. C.	Belfast and County Down, including—	12/3/77	—	—	—	
M. C.	Downpatrick, Dundrum, and Newcastle.	17/4/77	—	—	—	
M. C.	Belfast and Northern Counties, including :—	2/2/77	—	—	—	
M. C.	Ballymena and Larne	17/6/78	—	—	—	
M. C.	Carrickfergus and Larne	10/2/77	—	—	—	
—	Cork, Bandon, and South Coast Rly.	—	—	—	—	
—	Clogher Valley Light Railway or Tramway.	—	—	—	—	
M. C.	Draperstown	21/12/83	—	—	—	Worked by Belfast and Northern Counties.
M. C.	Dublin, Wicklow, and Wexford	26/3/77	—	—	—	
M. C.	Dundalk, Newry, and Greenore	9/5/77	—	—	—	Property of London and North-Western.
M. C.	Derry Central	27/5/80	—	—	—	Worked by Belfast and Northern Counties.
M. C.	Donegal, including :—	—	—	—	—	
M. C.	Finn Valley	26/3/77	—	—	—	
M. C.	West Donegal	26/10/82	—	—	—	
M. C.	Great Northern	26/3/77	—	—	—	
M. C.	Great Southern and Western, including :—	10/2/77	—	—	—	
M. C.	Kanturk and Newmarket	21/5/89	—	—	—	
M. C.	Listowel and Ballybunnion	20/2/88	—	—	—	
M. C.	Limavady and Dungiven	12/3/84	—	—	—	
M. C.	Midland Great Western	13/3/77	—	—	—	
M. C.	Tralee and Dingle Light Railway or Tramway.	8/10/90	—	—	—	
M. C.	Waterford and Tramore	—	—	1	—	
M. C.	Waterford and Central Ireland	5/1/77	—	—	—	
M. C.	Waterford and Limerick, including—	2/2/77	—	—	—	
M. C.	Athenry and Ennis Junction	5/3/77	—	—	—	
M. C.	Athenry and Tuam	5/3/77	—	—	—	
M. C.	Athkeale and Newcastle Junction	5/3/77	—	—	—	Now Donegal.
M. C.	West Donegal	—	—	—	—	
M. C.	West Clare	27/4/87	—	—	—	
	Total	25	—	1	—	

SUMMARY.

	Byelaws made regulating General Traffic.		Do not carry Explosives.		Total Railways provided for.	Remarks.
	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.		
ENGLAND AND WALES - -	75	—	16	—	91	
SCOTLAND - - -	19	—	—	—	19	
IRELAND - - -	25	—	1	—	26	
Total - - -	119	—	17	—	136	

APPENDIX H.

CANAL COMPANIES, the BYELAWS of which have been confirmed, and Companies which decline to carry Explosives, up to 31st December 1893.

Byelaws. Whether Model Code, &c.	Name of Canal, &c.	Date of Sanction of Byelaws.		Explosives not carried.		Remarks.
		Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	
	ENGLAND AND WALES.					
M. C.	Aberdare Canal - - -	5/8/76	—	—	—	
M. C.	Aire and Calder Navigation -	7/11/76	—	—	—	Including the Port of Goole.
M. C.	Ancholme Drainage and Navigation	30/10/76	—	—	—	
M. C.	Ashton-under-Lyne Canal - -	13/11/76	—	—	—	Property of Manchester, Sheffield, and Lincolnshire Railway Company.
—	Avon River - - - -	—	—	1	—	
M. C.	Arun Navigation - - -	18/12/77	—	—	—	
M. C.	Ashby-de-la-Zouch Canal - -	2/7/77	—	—	—	Property of Midland Railway Company.
—	Barnsley Canal - - -	—	—	—	—	Included in Aire and Calder Navigation Company, to whom it has been conveyed under power given by Act of Parliament.
M. C.	Birmingham Canal Navigation -	21/12/76	—	—	—	
M. C.	Bridgewater Navigation, Limited -	21/6/76	—	—	—	Includes Runcorn Harbour.
—	Bude Canal - - -	—	—	1	—	
M. C.	Beverley Beck - - -	7/7/76	—	—	—	
—	Bure, Yare, and Waveney Rivers -	—	—	—	—	Included in byelaws made by Great Yarmouth Port and Haven Commissioners.
M. C.	Birmingham and Liverpool Junction Canal.	21/4/77	—	—	—	Property of Shropshire Union Railway Company.
M. C.	Brecon and Abergavenny Canal -	17/1/77	—	—	—	Property of Great Western Railway Company.
M. C.	Bridgewater and Taunton Canal -	11/4/77	—	—	—	
M. C.	Bradford Canal - - -	18/8/80	—	—	—	
M. C.	Calder and Hebble Navigation -	17/9/76	—	—	—	
M. C.	Chelmer and Blackwater Navigation	4/7/76	—	—	—	
M. C.	Chesterfield Canal - - -	13/11/76	—	—	—	Property of Manchester, Sheffield, and Lincolnshire Railway Company.
M. C.	Coventry Canal - - -	23/2/77	—	—	—	
	Carried forward - -	17	—	2	—	

Byelaws. Whether Model Code, &c.	Name of Canal, &c.	Date of Sanction of Byelaws.		Explosives not carried.		Remarks.
		Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	
	ENGLAND AND WALES—*continued.*					
	Brought forward - -	17	—	2	—	
M. C.	Cromford Canal - -	2/7/77	—	—	—	
M. C.	Chester Canal - - -	21/4/77	—	—	—	Property of Shropshire Union Railway Company.
M. C.	Dear and Dove Canal - -	13/11/76	—	—	—	Property of Manchester, Sheffield, and Lincolnshire Railway Company.
—	Driffield Canal - - -	—	—	1	—	
M. C.	Droitwich Canal - - -	22/6/76	—	—	—	Property of Sharpness New Docks and Birmingham Navigation Company.
M. C.	Droitwich Junction Canal - -	—	1	—	—	
M. C.	Dun River Navigation - -	13/11/76	—	—	—	Property of Manchester, Sheffield, and Lincolnshire Railway Company.
M. C.	Derby Canal - - -	21/4/77	—	—	—	
M. C.	Derwent River - - -	13/8/77	—	—	—	
M. C.	Erewash Canal - - -	8/7/76	—	—	—	
M. C.	Exe River and Exeter Canal (Exeter Canal, and within that portion of the Port of Exeter situate within the Cheekstone Rock, except such portions thereof as are included within the prescribed limits of the Exe Bight Pier Company and the Exmouth Dock Company.)	1/8/76	—	—	—	
M. C.	Ellesmere and Chester Canal -	21/4/77	—	—	—	Property of Shropshire Union Railway.
Special	Foss River - - -	27/8/88	—	—	—	
M. C.	Fossdyke Navigation - -	27/10/76	—	—	—	Property of Great Northern Railway Company.
—	Gipping River - - -	—	—	—	—	Property of Great Eastern Railway Company. Included in Stowmarket Navigation.
M. C.	Glamorganshire Canal Navigation -	25/7/89	—	—	—	
M. C.	Gloucester and Berkeley Canal -	22/6/76	—	—	—	Property of Sharpness New Dock and Birmingham Navigation Company.
—	Grand Surrey Canal - -	—	—	1	—	Included in Surrey Commercial Dock Company, who absolutely prohibit the introduction of explosives.
M. C.	Grand Union Canal - - -	28/6/76	—	—	—	
M. C.	Grantham Canal - - -	27/10/76	—	—	—	Property of Great Northern Railway Company.
M. C.*	Grand Junction Canal - -	15/12/79	—	—	—	*Model code, but a special clause (12) was added prohibiting the master of any boat carrying explosive from entering any tunnel without giving notice to the captain of the Company's tugs at Blisworth and Braunston respectively, and from passing into either of those tunnels at a less distance than 500 yards from the last boat in tow of any steam tug.
M. C.	Grand Western Canal - -	11/4/77	—	—	—	
	Carried forward - -	35	1	4	—	

Byelaws. Whether Model Code, &c.	Name of Canal, &c.	Date of Sanction of Byelaws.		Explosives not carried.		Remarks.
		Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	
	ENGLAND AND WALES—*continued.*					
	Brought forward - -	35	1	4	—	
M. C.	Hereford and Gloucester Canal -	11/4/77	—	—	—	Property of Great Western Railway Company.
—	Horncastle Navigation - -	—	—	1	—	
M. C.	Huddersfield and Manchester Canal	24/6/76	—	—	—	Property of London and North-Western Railway Company.
M. C.	Kennet and Avon Canal (including River Avon from Bath to Hanham Mills).	11/4/77	—	—	—	Property of Great Western Railway Company.
M. C.	Knutbrook Canal - - -	25/9/76	—	—	—	
M. C.	Lancaster Canal - - -	24/6/76	—	—	—	Property of London and North-Western Railway Company.
M. C.	Leeds and Liverpool Canal (the Leeds and Liverpool Canal, the Leigh branch thereof, the South Level of the Lancaster Canal and the Douglas Navigation).	13/11/76	—	—	—	
M. C.	Leicester Navigation - - -	8/7/76	—	—	—	
M. C.	Leicestershire and Northampton Union Canal.	21/6/76	—	—	—	
—	Leven Canal - - -	—	—	1	—	
M. C.	Loughborough Navigation - -	8/7/76	—	—	—	
—	Lee River - - -	—	—	—	—	All explosives conveyed in Government barges.
M. C.	Louth Canal - - - -	18/9/77	—	—	—	
M. C.	Middle Level Navigation - -	14/12/76	—	—	—	
M. C.	Macclesfield Canal - - -	13/11/76	—	—	—	Property of Manchester, Sheffield, and Lincolnshire Railway Company.
M. C.	Manchester, Bolton, and Bury Canal	23/3/78	—	—	—	Property of Lancashire and Yorkshire Railway Company.
M. C.	Market Weighton Canal - -	30/10/77	—	—	—	Property of North-Eastern Railway Company.
M. C.	Medway Navigation - -	5/2/77	—	—	—	
M. C.	Mersey and Irwell Navigation -	1/9/77	—	—	—	Property of Bridgwater Navigation Company, Limited.
M. C.	Monmouthshire Canal - -	11/4/77	—	—	—	Property of Great Western Railway Company.
M. C.	Montgomeryshire Canal - -	21/4/77	—	—	—	Property of Shropshire Union Railway Company.
M. C.	Newark Navigation - - -	8/12/76	—	—	—	
M. C.	Neath Canal - - -	28/9/76	—	—	—	
M. C.	Nene Valley Drainage and Navigation (2nd District).	19/8/76	—	—	—	
M. C.	Nene Navigation (3rd Division) -	20/12/76	—	—	—	
—	North Walsham and Dilham Canal	—	—	1	—	
M. C.	Nottingham and Grantham Canal -	27/10/76	—	—	—	Property of Great Northern Railway Company.
M. C.	Nutbrook Canal - - -	25/9/76	—	—	—	
M. C.	Newcastle-under-Lyne Canal -	10/8/77	—	—	—	Property of North Staffordshire Railway Company.
M. C.	North Wilts Canal - -	—	—	—	—	Included in Wilts and Berks Canal.
M. C.	Norwich and Lowestoft Navigation and Haddiscoe Cut.	1/2/77	—	—	—	Property of Great Eastern Railway Company.
M. C.	Old Chester Canal - -	21/4/77	—	—	—	Property of Shropshire Union Railway Company.
M. C.	Oxford Canal - -	12/9/77	—	—	—	
	Carried forward - -	63	1	7	—	

Byelaws. Whether Model Code, &c.	Name of Canal, &c.	Date of Sanction of Byelaws.		Explosives not carried.		Remarks.
		Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	
	ENGLAND AND WALES—*continued.*					
	Brought forward - -	63	1	7	—	
—	Ouse River, Sussex - - -	—	—	—	—	Included in Newhaven Harbour.
M. C.	Ouse River, York - - -	8/12/77	—	—	—	York Corporation Conservators and Trustees.
M C.	Peak Forest Canal - - -	13/11/76	—	—	—	Property of Manchester, Sheffield, and Lincolnshire Railway Company.
—	Portsmouth and Arundel Canal -	—	—	1	—	
M. C.	Pocklington Canal - -	30/10/77	—	—	—	Property of North-Eastern Railway Company.
M. C.*	Regent's Canal (including Hertford Union Canal, Limehouse Basin, and the City Road Basin).	17/1/77	—	—	—	* Addition to No. 9.
M. C.	Rochdale Canal - - -	16/1/77	—	—	—	
M. C.	Ramsden's (Sir John) Canal - -	24/6/76	—	—	—	Property of London and North-Western Railway Company.
M. C.	St. Helen's Canal - - -	24/6/76	—	—	—	Property of London and North-Western Railway Company.
M. C.	Sharpness New Docks - -	22/6/76	—	—	—	
M. C.	Sheffield Canal - - -	13/11/76	—	—	—	Property of Manchester, Sheffield, and Lincolnshire Railway Company.
M. C.	Severn and Wye and Severn Bridge Railway Company's Navigation and Wharves.	14/11/85	—	—	—	
M. C.	Severn Navigation Company - -	23/5/76	—	—	—	
—	Sleaford Navigation - -	—	—	1	—	
M. C.	Staffordshire and Worcestershire Canal.	7/6/76	—	—	—	
M. C.	Stainforth and Keadby Canal -	13/11/76	—	—	—	Property of Manchester, Sheffield, and Lincolnshire Railway Company.
M. C.	Stowmarket and Ipswich Navigation	7/12/76	—	—	—	Property of Great Eastern Railway Company.
M. C.	Stover Canal - - -	11/4/77	—	—	—	Property of Great Western Railway Company.
M. C.	Swansea Canal - -	11/4/77	—	—	—	
M. C.	Shrewsbury Canal - -	21/4/77	—	—	—	Property of Shropshire Union Railway Company.
M. C.	Stourbridge Canal - -	21/7/76	—	—	—	
M. C.	Stourbridge Extension Canal -	11/4/77	—	—	—	Property of Great Western Railway Company.
M. C.	Stort River - - -	14/8/77	—	—	—	
M. C.	Stroudwater Navigation - -	8/12/76	—	—	—	
M. C.	Stratford-upon-Avon Canal -	11/4/77	—	—	—	Property of Great Western Railway Company.
M. C.	Thames and Severn Canal - -	4/7/76	—	—	—	
M. C.	Trent River - - - -	7/12/76	—	—	—	
M. C.	Trent and Mersey Canal - -	10/8/77	—	—	—	Property of North Staffordshire Railway Company.
M. C.	Tennant Canal - - -	31/1/77	—	—	—	
M. C.	Ure River - - -	30/10/77	—	—	—	North-Eastern Railway Company.
M. C. Slight modification.	Ulverstone Canal - - -	14/12/76	—	—	—	Property of Furness Railway Company.
M. C.	Weaver River Navigation - -	8/10/81	—	—	—	
M. C.	Wisbech Canal - - -	5/8/76	—	—	—	
M. C.	Witham River - - -	27/10/76	—	—	—	Property of Great Northern Railway Company.
M. C.	Worcester and Birmingham Navigation.	22/6/76	—	—	—	Property of Sharpness New Docks and Birmingham Navigation Company.
M. C.	Wilts and Berks Canal - -	10/1/77	—	—	—	
	Total - - -	96	1	9	—	

LIST of CANAL COMPANIES the BYELAWS of which have been CONFIRMED, and of the Companies which decline to carry Explosives, up to 31st December 1893.

Byelaws. Whether Model Code, &c.	Name of Canal, &c.	Date of Sanction of Byelaws.		Explosives not carried.		Remarks.
		Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	
	SCOTLAND.					
M. C. Slight modification.	Caledonian Canal, including :— Crinan Canal.	22/12/76	—	—	—	
—	Edinburgh and Glasgow Union Canal	—	—	1	—	Property of North British Railway Company.
M. C. Slight modification.	Forth and Clyde Canal, including :— Monkland Canal.	11/5/77	—	—	—	Included in Forth and Clyde Canals and Caledonian Railway Company.
M. C.	Glasgow, Paisley, and Johnstone -	10/6/76	—	—	—	Property of Glasgow and South-Western Railway Company.
	Total - -	3	—	1	—	

LIST of CANAL COMPANIES the BYELAWS of which have been CONFIRMED, and of Companies which decline to carry Explosives, to 31st December 1893.

Byelaws. Whether Model Code, &c.	Name of Canal, &c.	Date of Sanction of Byelaws.		Explosives not carried.		Remarks.
		Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	
	IRELAND.					
—	Barrow Navigation - -	—	—	1	—	
M. C.	Grand Canal - - - -	11/8/76	—	—	—	
M. C.	Lagan Navigation - - -	13/12/76	—	—	—	
M. C.	Newry Navigation - - -	8/9/76	—	—	—	
M. C.	Royal Canal - - -	21/9/76	—	—	—	Midland Great Western Railway Company of Ireland.
—	Lower Boyne Navigation - -	18/9/78	—	—	—	Property of the Commissioners of Public Works in Ireland.
M. C.	Margui Navigation - -	12/9/78	—	—	—	
M. C.	Shannon Navigation - -	12/9/78	—	—	—	
M. C.	Tyrone Navigation - -	12/9/78	—	—	—	
M. C.	Ulster Canal - - -	12/9/78	—	—	—	
	Total - -	9	—	1	—	

SUMMARY.

	Byelaws made regulating General Traffic.		Do not carry Explosives.		Total Canals provided for.	Remarks.
	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.		
ENGLAND AND WALES - - -	96	1	9	—	106	
SCOTLAND - - - -	3	—	1	—	4	
IRELAND - - - -	9	—	1	—	10	
TOTAL - -	108	1	11	—	120	

APPENDIX I.

HARBOURS and DOCKS for which BYELAWS have been made, and HARBOURS and DOCKS in which the TRAFFIC in EXPLOSIVES has been prohibited, up to 31st December 1893.

Place.	Under Explosives Act.						Where either (*a*) no Trade in Explosives exists; or (*b*) where such Traffic has been prohibited by Powers other than the Explosives Act.	
	Byelaws made regulating General Traffic.		Byelaws made limiting Traffic to 30 lbs.		Byelaws made prohibiting Traffic.			
	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.
ENGLAND AND WALES.								
Aberdovey*	1	—	—	—	—	—	—	—
Aberystwith	1	—	—	—	—	—	—	—
Alexandra Docks (Hull)†	1	—	—	—	—	—	—	—
Amlwch	1	—	—	—	—	—	—	—
Arundel	1	—	—	—	—	—	—	—
Barrow Docks and Harbour*	1	—	—	—	—	—	—	—
Barmouth	1	—	—	—	—	—	—	—
Blakeney and Clay	—	—	—	—	—	—	1	—
Blyth Harbour and Docks	1	—	—	—	—	—	—	—
Birkenhead (*see* Mersey)	—	—	—	—	—	—	—	—
Boston	—	—	—	—	1	—	—	—
Bridport	1	—	—	—	—	—	—	—
Bristol*	1	—	—	—	—	—	—	—
Bridgwater	1	—	—	—	—	—	—	—
Bridlington	1	—	—	—	—	—	—	—
Broadstairs	—	—	—	—	1	—	—	—
Bude Haven	—	—	—	—	—	—	1	—
Burry Navigation (*see also* Llanelly)	—	—	—	—	1	—	—	—
Cardiff (and Bute Docks)	—	—	—	—	—	—	1	—
Carnarvon	1	—	—	—	—	—	—	—
Cattewater	1	—	—	—	—	—	—	—
Chepstow	—	—	—	—	1	—	—	—
Clovelly	—	—	—	—	1	—	—	—
Cowes (Isle of Wight)	1	—	—	—	—	—	—	—
Conway Harbour*	1	—	—	—	—	—	—	—
Conway River (outside Harbour Commissioners' jurisdiction).	—	—	—	—	1	—	—	—
Colchester	1	—	—	—	—	—	—	—
Colne (*see* Colchester)	—	—	—	—	—	—	—	—
Combmartin	—	—	—	—	1	—	—	—
Dartmouth	1	—	—	—	—	—	—	—
Dover Harbour	—	—	1	—	—	—	—	—
Dover (Government Pier)	—	—	—	—	1	—	—	—
Devonport (*see also* Hamoaze)	1	—	—	—	—	—	—	—
East and West India Docks	—	—	—	—	1	—	—	—
Exeter and Exmouth	1	—	—	—	—	—	—	—
Falmouth	1	—	—	—	—	—	—	—
Fareham (included in Portsmouth)	—	—	—	—	—	—	—	—
Faversham	1	—	—	—	—	—	—	—
Fleetwood	—	—	—	—	1	—	—	—
Foss River‡	—	—	—	—	—	—	—	—
Fowey	1	—	—	—	—	—	—	—
Carried forward	23	—	1	—	10	—	3	—

* Approved by Customs. † *See also* Hull Docks. ‡ *See* Appendix G.

Place.	Under Explosives Act.						Where either (*a*) no Trade in Explosives exists; or (*b*) where such Traffic has been prohibited by Powers other than the Explosives Act.	
	Byelaws made regulating General Traffic.		Byelaws made limiting Traffic to 30 lbs.		Byelaws made prohibiting Traffic.			
	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.
ENGLAND AND WALES—*cont.*								
Brought forward	23	—	1	—	10	—	3	—
Garston Dock	1	—	—	—	—	—	—	—
Goole*	1	—	—	—	—	—	—	—
Great Western Docks (Plymouth)	1	—	—	—	—	—	—	—
Gosport (included in Portsmouth)	—	—	—	—	—	—	—	—
Great Yarmouth	1	—	—	—	—	—	—	—
Grimsby Docks†	—	—	—	—	—	—	—	—
Hamoaze	1	—	—	—	—	—	—	—
Hartlepool Docks†	—	—	—	—	—	—	—	—
Hartlepool	—	—	—	—	1	—	—	—
Hayle (Lelant Quays)	—	—	—	—	—	—	1	—
Hayle Port	1	—	—	—	—	—	—	—
Harwich	1	—	—	—	—	—	—	—
Holyhead	—	—	—	—	1	—	—	—
Hull Docks (Kingston)*	1‡	—	—	—	—	—	—	—
Hull (Old Harbour)	—	—	—	—	1	—	—	—
Humber*	1	—	—	—	—	—	—	—
Ilfracombe	1	—	—	—	—	—	—	—
Ipswich	1	—	—	—	—	—	—	—
Kidwelly	—	—	—	—	—	—	1	—
King's Lynn*	1	—	—	—	—	—	—	—
Laugharne (*see* Taff)	—	—	—	—	—	—	—	—
Lancaster	—	—	—	—	—	—	1	—
Littlehampton	1	—	—	—	—	—	—	—
Liverpool*	1	—	—	—	—	—	—	—
Llanelly (*see* Burry)	—	—	—	—	—	—	—	—
London and St. Katherine Docks†	—	—	—	—	—	—	—	—
Looe	—	—	—	—	—	—	1	—
Lowestoft	1	—	—	—	—	—	—	—
Lymington River	1	—	—	—	—	—	—	—
Lymington Harbour	1	—	—	—	—	—	—	—
Llanerchymor	1§	—	—	—	—	—	—	—
Llandulas Pier	1	—	—	—	—	—	—	—
Margate	—	—	1	—	—	—	—	—
Maryport	—	—	—	—	1	—	—	—
Menai Bridge Pier	—	—	—	—	—	—	1	—
Medway	1	—	—	—	—	—	—	—
Mersey, Upper*	1	—	—	—	—	—	—	—
Mersey, Lower*	1	—	—	—	—	—	—	—
Milford Haven	1	—	—	—	—	—	—	—
Millwall Docks	—	—	—	—	—†	—	—	—
Middlesboro' Docks†	—	—	—	—	—	—	—	—
Minehead	1	—	—	—	—	—	—	—
Mousehole	—	—	—	—	—	—	1	—
Neath	1	—	—	—	—	—	—	—
Newhaven	—	—	1	—	—	—	—	—
Newport (Isle of Wight)	1	—	—	—	—	—	—	—
Carried forward	49	—	3	—	14	—	9	—

* Approved by Customs.
‡ Amorces or toy caps only.
† *See* Appendix G.
§ Amended byelaws sanctioned during the year.

Place.	Under Explosives Act.						Where either (*a*) no Trade in Explosives exists; or (*b*) where such Traffic has been prohibited by Powers other than the Explosives Act.	
	Byelaws made regulating General Traffic.		Byelaws made limiting Traffic to 30 lbs.		Byelaws made prohibiting Traffic.			
	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.
ENGLAND AND WALES—*cont.*								
Brought forward	49	—	3	—	14	—	9	—
Newport (Mon.)*	1	—	—	—	—	—	—	—
New Quay (Cardigan)	—	—	—	—	—	—	1	—
New Quay (Cornwall)	1	—	—	—	—	—	—	—
North Sunderland	—	—	—	—	—	—	1	—
Orford Haven and River Ore	—	—	—	—	1	—	—	—
Pembrey*	1	—	—	—	—	—	—	—
Penryn*	1	—	—	—	—	—	—	—
Plymouth*	1	—	—	—	—	—	—	—
Poole	1	—	—	—	—	—	—	—
Porthleven	1	—	—	—	—	—	—	—
Portsmouth (including Fareham and Gosport).*	1	—	—	—	—	—	—	—
Penzance*	1	—	—	—	—	—	—	—
Portishead Docks	1	—	—	—	—	—	—	—
Portland	1	—	—	—	—	—	—	—
Portmadoc*	1	—	—	—	—	—	—	—
Penarth*	1	—	—	—	—	—	—	—
Queenborough	1	—	—	—	—	—	—	—
Ramsgate	—	—	1	—	—	—	—	—
Runcorn	1	—	—	—	—	—	—	—
Rye	—	—	1	—	—	—	—	—
Rochester	1	—	—	—	—	—	—	—
Saundersfoot	1	—	—	—	—	—	—	—
Scarborough	1	—	—	—	—	—	—	—
Sharpness New Docks†	—	—	—	—	—	—	—	—
Shoreham (New)	1	—	—	—	—	—	—	—
Silloth	—	—	—	—	1	—	—	—
Southampton (Pier and Harbour)*	1	—	—	—	—	—	1	—
Southwold	—	—	—	—	—	—	1	—
Spalding	—	—	—	—	—	—	—	—
Sunderland	—	—	—	—	1	—	—	—
Sutton	1	—	—	—	—	—	—	—
Swansea	1	—	—	—	—	—	—	—
Surrey Commercial Dock	—	—	—	—	1	—	—	—
Taff River	—	—	—	—	1	—	—	—
Tees	1	—	—	—	—	—	—	—
Teignmouth	1	—	—	—	—	—	—	—
Tetney Haven	—	—	—	—	—	—	1	—
Thames*	1	—	—	—	—	—	—	—
Truro	1	—	—	—	—	—	—	—
Tyne (Port)*	1	—	—	—	—	—	—	—
Tyne Dock†	—	—	—	—	—	—	—	—
Watchet	1	—	—	—	—	—	—	—
Wearmouth Dock†	—	—	—	—	—	—	1	—
Weston-super-Mare	—	—	—	—	—	—	—	—
West Hartlepool Dock†	—	—	—	—	—	—	—	—
Whitby	1	—	—	—	1	—	—	—
Widnes Dock	—	—	—	—	—	—	—	—
Wisbech	1	—	—	—	—	—	—	—
Whitehaven*	1	—	—	—	1	—	—	—
Workington	—	—	—	—	—	—	—	—
Total	80	—	5	—	21	—	15	—

* Approved by Customs.

† *See* Appendix G.

HARBOURS and DOCKS for which BYELAWS have been made, and HARBOURS and DOCKS in which the TRAFFIC in EXPLOSIVES has been prohibited, up to 31st December 1893.

Place.	Under Explosives Act.						Where either (*a*) no Trade in Explosives exists; or (*b*) where such Traffic has been prohibited by Powers other than the Explosives Act.	
	Byelaws made regulating General Traffic.		Byelaws made limiting Traffic to 30 lbs.		Byelaws made prohibiting Traffic.			
	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.
SCOTLAND.								
Aberdeen	1	—	—	—	—	—	—	—
Aberdour	—	—	—	—	—	—	1	—
Anstruther	—	—	—	—	1	—	—	—
Arbroath	—	—	—	—	1	—	—	—
Ardrossan	1	—	—	—	—	—	—	—
Ayr	1	—	—	—	—	—	—	—
Balmerino	—	—	—	—	1	—	—	—
Banff	—	—	—	—	1	—	—	—
Blackpots	—	—	—	—	1	—	—	—
Boddam	—	—	—	—	1	—	—	—
Borrowstounness	—	—	—	—	1	—	—	—
Bowling Bay Wharf	—	—	—	—	—	—	1	—
Bowling, West (*see* Glasgow)	—	—	—	—	—	—	—	—
Broughty Ferry	—	—	—	—	1	—	—	—
Brora	—	—	—	—	—	—	1	—
Buckhaven	—	—	—	—	1	—	—	—
Burghead	—	—	—	—	1	—	—	—
Burntisland	1*	—	—	—	—	—	—	—
Cart Navigation	1	—	—	—	—	—	—	—
Castlehill	—	—	—	—	—	—	1	—
Charlestown	—	—	—	—	1	—	—	—
Clyde	1*	—	—	—	—	—	—	—
Crail	—	—	—	—	1	—	—	—
Cullen	—	—	—	—	1	—	—	—
Dalbeattie	—	—	—	—	—	—	1	—
Drumore	—	—	—	—	—	—	1	—
Dundee	—	—	1	—	—	—	—	—
Dysart	—	—	—	—	1	—	—	—
Eday Pier and Harbour (*see* Holm St. Mary's).	—	—	—	—	—	—	—	—
Elgin and Lossiemouth	1	—	—	—	—	—	—	—
Fisherrow	—	—	—	—	—	—	1	—
Fort William	—	—	1	—	—	—	—	—
Fraserburgh	—	—	—	—	1	—	—	—
Frisky Wharf	1†	—	—	—	—	—	—	—
Forth and Clyde Navigation (including Bowling Harbour and Harbour and Docks of Grangemouth).	—	—	—	—	—	—	1	—
Forth Navigation. (For that part of the river Forth situated between Alloa and Stirling.)	—	—	—	—	1	—	—	—
Findochty	—	—	—	—	1	—	—	—
Garmouth	—	—	—	—	1	—	—	—
Gatehouse or Port McAdam	—	—	—	—	1	—	—	—
Girvan	—	—	—	—	1	—	—	—
Glasgow (*see* Clyde)*	—	—	—	—	—	—	—	—
Greenock (*see* Clyde)	—	—	—	—	—	—	—	—
Gourdan	—	—	—	—	—	—	1	—
Guardbridge	—	—	—	—	—	—	1	—
Grangemouth* (*see* Forth and Clyde Navigation).	—	—	—	—	—	—	—	—
Granton	—	—	—	—	1	—	—	—
Carried forward	8	—	2	—	21	—	10	—

* Approved by Customs.

† Regulating traffic in *gunpowder* only. There are other byelaws prohibiting traffic in explosives other than gunpowder.

Place.	Under Explosives Act.						Where either (*a*) no Trade in Explosives exists; or (*b*) where such Traffic has been prohibited by Powers other than the Explosives Act.	
	Byelaws made regulating General Traffic.		Byelaws made limiting Traffic to 30 lbs.		Byelaws made prohibiting Traffic.			
	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.
SCOTLAND—*cont.*								
Brought forward	8	—	2	—	21	—	10	—
Helmsdale	—	—	—	—	—	—	1	—
Holm (St. Mary's) Pier and Harbour	1	—	—	—	—	—	—	—
Irvine*	1	—	—	—	—	—	—	—
Invergordon	1	—	—	—	—	—	—	—
Inverness	—	—	1	—	—	—	—	—
Kingsbarns	—	—	—	—	—	—	1	—
Kingston (*see also* Garmouth)	—	—	—	—	1	—	—	—
Kirkcaldy	1	—	—	—	—	—	—	—
Kirkcudbright	—	—	—	—	1	—	—	—
Kirkwall	1	—	—	—	—	—	—	—
Largo	—	—	—	—	1	—	—	—
Largs	—	—	—	—	—	—	1	—
Leith*	1	—	—	—	—	—	—	—
Little Ferry	—	—	1	—	—	—	—	—
Lybster	—	—	1	—	—	—	—	—
Macduff	—	—	—	—	1	—	—	—
Methill	—	—	—	—	1	—	—	—
Montrose	—	—	—	—	—	—	1	—
Morrisonshaven	—	—	—	—	1	—	—	—
Newbiggin	—	—	—	—	—	—	1	—
Newburgh Shore	—	—	—	—	—	—	1	—
Newport (near Dundee)	—	—	—	—	—	—	1	—
Pittenweem	—	—	—	—	1	—	—	—
Port Edgar	—	—	—	—	1	—	—	—
Port Gordon	—	—	—	—	1	—	—	—
Port Logan	—	—	—	—	—	—	1	—
Port McAdam (*see also* Gatehouse)	—	—	—	—	1	—	—	—
Pulteney (Wick)	1	—	—	—	—	—	—	—
Pettycur	—	—	—	—	1	—	—	—
Portmahomack	1	—	—	—	—	—	—	—
Portsoy	—	—	—	—	1	—	—	—
Peterhead	1	—	—	—	—	—	—	—
Queensferry North (Piers)	—	—	—	—	1	—	—	—
Queensferry South (Piers)	—	—	—	—	1	—	—	—
Rosehearty	—	—	—	—	1	—	—	—
Scapa Pier and Harbour (*see* Holm St. Mary's).	—	—	—	—	—	—	—	—
Stornoway	1	—	—	—	—	—	—	—
St. David's	—	—	—	—	1	—	—	—
Sanday Pier	1	—	—	—	—	—	—	—
Sandhaven	—	—	—	—	1	—	—	—
South Alloa	1	—	—	—	—	—	—	—
Stairhaven	—	—	—	—	—	—	1	—
Starlyburn	—	—	—	—	—	—	1	—
Tayport	—	—	—	—	1	—	—	—
Troon	—	—	—	—	1	—	—	—
							—	—
West Wemyss	—	—	—	—	1	—	—	—
Whitehills	—	—	—	—	1	—	—	—
Woodhaven	—	—	—	—	—	—	1	—
Total	20	—	5	—	42	—	21	—

* Approved by Customs.

HARBOURS and DOCKS for which BYELAWS have been made, and HARBOURS and DOCKS in which the TRAFFIC in EXPLOSIVES has been prohibited, up to 31st December 1893.

Place.	Under Explosives Act.						Where either (*a*) no Trade in Explosives exists; or (*b*) where such Traffic has been prohibited by Powers other than the Explosives Act.	
	Byelaws made regulating [1]General Trade.		Byelaws made limiting Traffic.		Byelaws made prohibiting Traffic.			
	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.
IRELAND.								
Annalong	1	—	—	—	—	—	—	—
Ardglass	—	—	—	—	1	—	—	—
Arklow	1	—	—	—	—	—	—	—
Ballywalter	1	—	—	—	—	—	—	—
Ballintoy	—	—	—	—	—	—	1	—
Bangor (County Down)	—	—	—	—	1	—	—	—
Belfast*	1	—	—	—	—	—	—	—
Burton Port	—	—	—	—	—	—	1	—
Balbriggan	1	—	—	—	—	—	—	—
Ballynass	—	—	1	—	—	—	—	—
Buncrana	—	—	1	—	—	—	—	—
Bruckless	—	—	1	—	—	—	—	—
Carnlough	1	—	—	—	—	—	—	—
Courtown	—	—	—	—	—	—	1	—
Clonakilty	1	—	—	—	—	—	—	—
Carrickfergus	1	—	—	—	—	—	—	—
Coleraine	1	—	—	—	—	—	—	—
Cork*	1	—	—	—	—	—	—	—
Clare Castle	1	—	—	—	—	—	—	—
Donaghadee	1	—	—	—	—	—	—	—
Dunmore	1	—	—	—	—	—	—	—
Dundalk*	1	—	—	—	—	—	—	—
Dublin*	1	—	—	—	—	—	—	—
Dundrum	—	—	—	—	1	—	—	—
Drogheda*	1	—	—	—	—	—	—	—
Foynes	1	—	—	—	—	—	—	—
Greenore*	—	—	—	—	1	—	—	—
Greencastle	—	—	1	—	—	—	—	—
Galway*	—	—	1†	—	—	—	—	—
Howth	1	—	—	—	—	—	—	—
Inniscoo	—	—	—	—	—	—	1	—
Jeelin	—	—	—	—	—	—	1	—
Killough	—	—	—	—	1	—	—	—
Kilkeel	1	—	—	—	—	—	—	—
Kingstown	1	—	—	—	—	—	—	—
Kircubbin	—	—	—	—	1	—	—	—
Killybegs	—	—	1	—	—	—	—	—
Kilteery	1	—	—	—	—	—	—	—
Kildysart Pier and Harbour	1	—	—	—	—	—	—	—
Kilrush Pier and Harbour	1	—	—	—	—	—	—	—
Larne	1	—	—	—	—	—	—	—
Limerick*	1	—	—	—	—	—	—	—
Londonderry*	1	—	—	—	—	—	—	—
Leabgarrow	—	—	1	—	—	—	—	—
Mullaghmore	—	—	—	—	—	—	1	—
Moville	—	—	1	—	—	—	—	—
Mountcharles	—	—	1	—	—	—	—	—
Carried forward	26	—	9	—	6	—	6	—

* Non-prohibited Port, *i.e.*, Port into which explosives not requiring license under Explosives Act may be brought.
† 50 lbs.

Place.	Under Explosives Act.						Where either (*a*) no Trade in Explosives exists; or (*b*) where such Traffic has been prohibited by Powers other than the Explosives Act.	
	Byelaws made regulating General Trade.		Byelaws made limiting Traffic.		Byelaws made prohibiting Traffic.			
	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.	Previous to 1893.	During 1893.
IRELAND—*cont.*								
Brought forward	26	—	9	—	6	—	6	—
Newcastle (County Down)	1	—	—	—	—	—	—	—
Newry*	—	—	—	—	—	—	—	—
Portaferry	1	—	—	—	—	—	—	—
Port Rush	—	—	—	—	—	—	1	—
Portsalon	—	—	1	—	—	—	—	—
Portnablahey	—	—	1	—	—	—	—	—
Quoile	—	—	—	—	1	—	—	—
Querrin	1	—	—	—	—	—	—	—
Red Bay	1	—	—	—	—	—	—	—
Rogerstown	—	—	—	—	—	—	1	—
Rosslare	—	—	—	—	—	—	1	—
Rush	—	—	—	—	—	—	1	—
Rathmullan	—	—	1	—	—	—	—	—
Sligo*	1	—	—	—	—	—	—	—
Strangford	—	—	—	—	—	—	1	—
Saleen Pier and Harbour	1	—	—	—	—	—	—	—
Teelin	—	—	1	—	—	—	—	—
Westport* (Quay)	—	1	—	—	—	—	—	—
Wexford*	1	—	—	—	—	—	—	—
Waterford*	1	—	—	—	—	—	—	—
Total	34	1	13	—	7	—	11	—

* Non-prohibited Port, *i.e.*, Port into which explosives not requiring license under Explosives Act may be brought.

SUMMARY.

Country.	Byelaws Approved.									No. of Harbours and Docks the Authorities of which have either prohibited the Traffic of Explosives altogether under powers which they possess independently of the Explosives Act, 1875, or have represented that there is not and is not likely to be any Traffic in Explosives at their Harbours or Docks.			Total No. of Harbours and Docks provided for.
	Regulating Traffic in Explosives.			Limiting Traffic to 30 lbs.			Prohibiting Traffic under Explosives Act, 1875.						
	Previous to 1893.	During 1893.	Total.	Previous to 1893.	During 1893.	Total.	Previous to 1893.	During 1893.	Total.	Total.	Previous to 1893.	During 1893.	Total.	
ENGLAND AND WALES	80	—	80	5	—	5	21	—	21	106	15	—	15	121
SCOTLAND	20	—	20	5	—	5	42	—	42	67	21	—	21	88
IRELAND	34	1	35	13	—	13	7	—	7	54	11	—	11	66
TOTALS	134	1	135	23	—	23	70	—	70	227	47	—	47	275

APPENDIX J.

Abstract showing Total Amount of Explosive Imported.

Amorces.	Ballistite.	Bellite.	Carbonite.	Chilworth Smokeless Powder.	Cooppal's Powder.	Detonators.	Dynamite.	Emmensite.	Fortisine.
Lbs. 140 (H. J. Cadwell). 1,000 (J.D.Hewett & Co.)	Lbs. 37,188 (Chilworth Gunpowder Co., Lim.).	Lbs. 2,450 (Bellite Explosive, Limited). 12,000 (R. C. Briscoe). 99,000 (Lancashire Explosives Co., Lim.).	Lbs. 136,350 (A. F. Richter.)	Lbs. 100 (Chilworth Gunpowder Co., Lim.).	Lbs. 3,300 (J. R. Watson).	6 cases (R. C. Briscoe). 1,125,000 (J. Darlington). 4,990,000 (C. G. Mueller). 444,000 (A. F. Richter) 620,000 (J. R. Watson).	Lbs. 11,450 (Alliance Explosives Co., Lim.). 9,700 (R. C. Briscoe). 3,000 (J. Darlington). 50 (J. R. Watson).	Lbs. 10½ (Miners' Safety Explosives Co., Lim.).	Lbs. 20,000 (Fortis Powder and Explosive Co.,Lim.)
1,140 lbs.	37,188 lbs.	113,450 lbs.	136,350 lbs.	100 lbs.	3,300 lbs.	7,179,000 and 6 cases.	24,200 lbs.	10½ lb. sample.	20,000 lbs.

Fulminate of Mercury.	Fuzes for Shell.	Gelatine Dynamite. (including Gelignite).	Manufactured Fireworks.	Matagnite Gelatine.	Oriental Fireworks.	Plastomenite.	Plugs of Nitrated Guncotton and Nitro-Cellulose.	Shells (Hand Grenades).	Tubes for Firing Explosives.	Walsrode Powder.
Lbs. 9,680 (A. Helcké).	Lbs. 5,250 (Sir W. G. Armstrong, Mitchell, & Co., Lim.). 800 (Bridges and Forss). 60 fuzes (Laird, Bros.). 5,000 fuzes (Maxim-Nordenfelt Guns and Ammunition Co., Lim.).	Lbs. 119,550 (Alliance Explosives Co., Lim.). 22,500 (R. C. Briscoe). 258,000 (J. Darlington).	Lbs. 2,100 (C. T. Brock & Co.). 1,344 (Langstaff, Ehrenberg, & Pollak).	Lbs. 16,350 (J. R. Watson).	Lbs. 117,610 (C. T. Brock & Co.). 35,000 (Bridges & Forss). 170,000 (Pain & Sons). 54,000 (Samuel & Co.).	½ lb. sample (Müller & Co.).	50 (Alliance Explosives Co., Lim.).	Lbs. 25,300 (Bridges & Forss).	206 (Laird, Bros.)	Lbs. 5,000 (Beutner & Co.).
9,680 lbs.	6,050 lbs. 5,060 fuzes.	400,050 lbs.	3,444 lbs.	16,350 lbs.	376,610 lbs.	½ lb. sample.	50	25,300 lbs.	206	5,000 lbs.

APPENDIX K.

IMPORTATION LICENSES for EXPLOSIVES granted during 1893.

Class and Name of Explosive.			No. of Importation Licenses granted during 1893.
Class 2.	Nitrate Mixture - - -		—
Class 3.	Division 1.	Dynamite, Nos. 1 and 2* -	10
		Gelatine Dynamite, Nos. 1 and 2.*	14
		Blasting Gelatine, Nos. 1 and 2.*	6
		Ballistite* - - -	4
		Gelignite* - - -	1
		Matagnite Gelatine* -	1
		Carbonite* - - -	6
Class 3.	Division 2.	Chilworth Smokeless Powder	1
		Cooppal's Powder* - -	3
		Bellite* - - -	2
		Fortisine - -	1
		Walsrode Powder - -	3
Class 5.	Division 1.	Fulminate of Mercury -	7
Class 6.	Division 2.	Fuzes for Shell - -	7
		Shells - - -	2
		Tubes for firing Explosive -	1
	Division 3.	Detonators - -	17
Class 7.	Division 2.	Oriental Fireworks -	13
		Manufactured Fireworks -	2
		Amorces - - -	6
Miscellaneous—			
Compressed Plugs of high Nitrated Guncotton -			1
„ „ Soluble Nitro-Cellulose -			1
Plastomenite - - - -			1

* Including cartridges of Class 6, Division 2, made with the explosive.

APPENDIXL (*a*).

NON-PROHIBITED PORTS in IRELAND, under the PEACE PRESERVATION ACT, 1881, &c. *i.e.*, PORTS into which EXPLOSIVES not requiring a LICENSE under the EXPLOSIVES ACT, 1875, may be brought.

Name of Port.	County.	Harbour Authority.	Bye-laws. Approved Date.	Whether a Port approved by Customs.	Act under which authorised.
Belfast	Antrim	The Harbour Commissioners, Belfast	14/12/76	—	Authorised under Peace Preservation Act, Order in Council, 24th Feb. 1893. "The Peace Preservation (Ireland) Continuance Act, 1886," "The Criminal Law and Procedure (Ireland) Act, 1887," and "The Expiring Laws Continuance Act, 1892."
Carrickfergus	Antrim	The Carrickfergus Harbour Commissioners.	3/5/77	—	
Cork	Cork	The Cork Harbour Commissioners	14/7/77	—	
Drogheda	Louth	The Harbour Commissioners, Drogheda	8/5/77	—	
Dundalk	Louth	The Harbour Commissioners, Dundalk	1/11/78	—	
Dublin	Dublin	The Dublin Port and Docks Board	18/1/77	—	
Galway	Galway	The Harbour Commissioners, Galway	10/12/77	—	
Glenarm	Antrim	The Earl of Antrim, Glenarm Castle, Co. Antrim.	Nil.	—	
Greenore	Louth	The Dundalk and Greenore Railway Co., Greenore.	25/3/76*	—	
Larne	Antrim	James Chaine, Esq., Ballycraigey, co. Leitrim.	—	—	
Limerick	Limerick	The Harbour Commissioners, Limerick	5/8/78	—	
Londonderry	Londonderry	The Harbour Commissioners, Londonderry.	6/11/78	—	
Newry	Down	The Newry Navigation Co.	8/9/76	—	
Sligo	Sligo	The Harbour Commissioners, Sligo	23/10/76	—	
Waterford	Waterford	The Harbour Commissioners, Waterford	8/9/82	—	
Westport (Quay)	Mayo	The Westport Harbour Commissioners	5/5/93	—	
Wexford	Wexford	The Harbour Commissioners, Wexford	10/1/77	—	

* Greenore Harbour. PROHIBITORY Byelaws made.

APPENDIX L (*b*).

IMPORTATIONS of GUNPOWDER from the under-mentioned COUNTRIES, and the Total Import into the UNITED KINGDOM in each Year from 1870 to 1893 both inclusive.

Year.	Germany.		Holland.		Belgium.		Other Countries.		Total Import.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Cwt.	£	Cwt.	£	Cwt.	£	Cwt.	£	Cwt.	£
1870	—	—	—	—	1,175	6,580	12	68	1,187	6,648
1871	—	—	—	—	—	—	—	—	—	—
1872	—	—	—	—	5,730	17,140	—	—	5,730	17,140
1873	6	66	—	—	5,810	27,866	—	—	5,816	27,932
1874	—	—	—	—	892	4,000	—	—	892	4,000
1875	1,076	2,132	760	3,750	60	500	—	—	1,896	6,382
1876	—	—	—	—	—	—	60	672	60	672
1877	3,555	7,900	1,000	1,500	—	—	—	—	4,555	9,400
1878	1,125	2,500	210	1,490	—	—	—	—	1,335	3,990
1879	3,738	8,312	1,632	3,102	1,860	8,980	350	779	7,580	21,173
1880	2,899	13,161	1,933	8,660	—	—	—	—	4,832	21,821
1881	4,622	12,188	5,815	32,472	—	—	—	—	10,437	44,660
1882	7,719	29,968	1,403	7,162	—	—	—	—	9,122	37,130
1883	6,518	32,308	4,671	27,495	—	—	286	1,510	11,475	61,313
1884	1,361	3,260	4,973	26,490	448	1,133	—	—	6,782	30,883
1885	12,304	75,976	25,185	171,995	1,342	2,523	150	480	38,981	250,974
1886	9,735	70,095	10,965	63,013	662	4,046	620	3,090	21,982	140,244
1887	—	—	3,437	21,998	1,119	8,788	2,725	15,872	7,281	46,658
1888	1,475	9,514	4,417	24,404	676	1,982	477	1,733	7,045	37,633
1889	2,032	4,142	8,720	42,783	1,288	4,601	43	295	12,083	51,821
1890	8,562	16,456	3,782	16,920	1,316	4,554	73	347	13,733	38,277
1891	4,004	9,186	—	—	1,842	6,381	—	—	5,846	15,567
1892	884	8,688	314	514	2,580	8,968	38	370	3,816	18,540
1893	754	9,934	140	784	942	2,872	—	—	1,836	13,590

NOTE.—The quantity imported from Holland may be taken to represent gunpowder of German production.

APPENDIX L (*c*).

QUANTITY and VALUE of GUNPOWDER of British Produce exported from the UNITED KINGDOM in each of the years 1870 to 1893 inclusive.

Years.	Quantity.	Value.	Average value per cwt.
	Cwt.	£	£ s. d.
1870	154,979	427,229	2 15 9
1871	164,437	440,454	2 13 9
1872	177,586	485,434	2 14 1
1873	148,452	442,170	2 19 6
1874	133,312	415,716	3 2 4
1875	134,336	395,638	2 18 10
1876	127,399	359,722	2 16 5
1877	144,241	394,577	2 14 8
1878	126,994	349,178	2 14 11
1879	108,926	311,612	2 17 2
1880	133,281	372,585	2 15 11
1881	128,241	369,607	2 17 8
1882	126,634	356,320	2 16 3
1883	141,361	384,639	2 14 5
1884	142,721	387,392	2 14 3
1885	113,963	318,146	2 15 10
1886	103,555	288,725	2 15 9
1887	87,397	263,394	3 0 3
1888	120,746	363,270	3 0 2
1889	95,354	273,700	2 17 5
1890	92,236	252,828	2 14 10
1891	100,218	274,394	2 14 9
1892	70,855	203,327	2 17 5
1893	68,593	194,403	2 16 8

APPENDIX L (*d*).

QUANTITY and VALUE of GUNPOWDER of Foreign and Colonial Produce Exported from the UNITED KINGDOM in each of the years from 1870 to 1893 inclusive.

Years.	Quantity.	Value.
	Cwts.	£
1870	2,650	14,840
1871	—	—
1872	—	—
1873	—	—
1874	—	—
1875	780	3,851
1876	72	150
1877	1,100	3,696
1878	289	1,733
1879	867	3,177
1880	1,475	8,480
1881	2,713	11,373
1882	268	1,028
1883	1,527	8,433
1884	184	710
1885	3,689	16,298
1886	6,810	43,945
1887	1,266	7,603
1888	1,805	5,504
1889	2,915	17,568
1890	4,542	14,821
1891	1,250	4,575
1892	1,663	5,192
1893	326	1,591

Commercial Department, Board of Trade,
8th January 1894.

APPENDIX M.

Counties visited for the purpose of Inspection, &c. during the year.

ENGLAND AND WALES.

Anglesey.
Berkshire.
Bucks.
Cambridge.
Cardigan.
Carmarthen.
Carnarvon.
Cheshire.
Cornwall.
Cumberland.
Denbigh.
Derby.
Devon.
Durham.
Essex.
Flint.
Glamorgan.
Gloucester.
Hertford.
Kent.
Lancashire.
Leicester.
Merioneth.
Middlesex.
Monmouth.
Montgomery.
Northumberland.
Nottingham.
Pembroke.
Salop.
Somerset.
Southampton.
Stafford.
Suffolk.
Surrey.
Sussex.
Warwick.
Westmoreland.
Wiltshire.
Worcester.
Yorkshire.

Total, 40.

SCOTLAND.

Aberdeen.
Argyll.
Ayr.
Banff.
Clackmannan.
Dumbarton.
Edinburgh.
Fife.
Forfar.
Inverness.
Lanark.
Linlithgow.
Perth.
Renfrew.
Ross.
Stirling.

Total, 16.

IRELAND.

Antrim.
Cork.
Down.
Dublin.
Galway.
Limerick.
Londonderry.

Total, 7.

Grand Total, 63.

APPENDIX N.

Visits to Borough and Urban Sanitary Local Authorities since the Act came into operation.

ENGLAND AND WALES.

Aberystwith.*
Abingdon.*
Ambleside.*
Andover.*
Appleby.
Arundel.*
Banbury.*
Barnstaple.
Barrow.
Basingstoke.*
Bath.
Battle.*
Beaumaris.*
Bedford.
Bedminster. (Somerset, part of Bristol).
Belper.
Bethesda.*
Beverley.
Bideford.
Birmingham.*
Blackburn.
Bodmin.
Bolton.
Bootle.
Boston.
Bradford.
Brecon.*
Bridgnorth.*
Bridgwater.
Brighton.
Bristol.
Buckingham.*
Burnley.
Bury.
Buxton.
Cambridge.
Canterbury.
Cardiff.
Cardigan.*
Carlisle.
Carmarthen.
Carnarvon.
Chester.
Chesterfield.
Chichester.*
Cockermouth.
Colchester.
Coventry.
Croydon.
Dartmouth.*
Deal.*
Denbigh.*
Derby.
Devonport.
Dewsbury.
Doncaster.
Dorchester.*
Dover.
Droitwich.*
Dudley.
Durham.
Ely.
Exeter.
Falmouth.*
Faversham.*
Festiniog.*
Flint.*
Folkestone.*
Frome.
Gateshead.
Glastonbury.*
Gloucester.
Gosport.
Grantham.
Gravesend.
Great Grimsby.
Great Torrington.
Great Yarmouth.
Guildford.
Halifax.
Hanley.
Hartlepool.
Harwich.*
Hastings.
Haverfordwest.*
Helston.*
Herne Bay.*
Hereford.
Hertford.
High Wycombe.
Honiton.
Hove.
Huddersfield.
Hull.
Hythe.*
Ilfracombe.*
Ipswich.
Kendal.
Kidderminster.
Kingston-on-Thames.
Leamington.
Leeds.
Leicester.
Lewes.*
Lichfield.*
Lincoln.
Liskeard.
Liverpool.
Llandilo.
Llandovery.*
London City.
Lynn.
Maidenhead.*
Maidstone.
Malmesbury.*
Manchester.
Margate.
Middlesboro'.
Mold.*
Monmouth.
Morley.
Much Wenlock.
Neath.
Newark.
Newbury.
Newcastle-upon-Tyne.
Newport* (I. of W.).
Newport (Mon.)
Northampton.
Norwich.
Nottingham.
Oldham.
Oswestry.*
Oxford.
Penrhyn.*
Penzance.
Peterboro'.
Plymouth.
Pontefract.*
Pontypridd.
Poole.
Portmadoc.
Portsmouth.
Preston.
Ramsgate.
Reading.
Reeth.*
Reigate.
Richmond, Yorks.*
Ripon.*
Rochdale.
Rochester.
Romsey.*
Rotherham.
Runcorn.
Ruthin.*
Ryde.
Rye.*
Salford.
Salisbury.
Sandwich.*
Scarborough.
Sheffield.
Shrewsbury.
Southampton.
South Molton.*
Southport.
South Shields.
Stafford.
Stratford.*
St. Albans.
St. Helen's.
St. Ives, Cornwall.*
Sunderland.
Swansea.
Tenby.*
Tewkesbury.*
Thetford.*
Tiverton.
Totnes.*
Truro.
Tunbridge Wells.
Tynemouth.
Ulverston.
Wakefield.
Wallingford.*
Walsall.
Wareham.
Warwick.
Wells, Norfolk.
Wells, Somerset.*
Weymouth.
Whitehaven.*
Wigan.
Windsor.
Winchester.
Wisbech.*
Wolverhampton.
Worcester.
Worksop.
Wrexham.
Yarmouth.
Yeovil.
York.

Total, 204.

* Not Local Authorities under Explosives Act, 1875.

SCOTLAND.

Aberdeen.	Forfar.	Linlithgow.
Airdrie.	Forres.	Montrose.
Alloa.	Fortrose.	Musselburgh.
Arbroath.	Galashiels.	Nairn.
Ayr.	Glasgow.	Oban.
Banff.	Govan.	Paisley.
Berwick.	Greenock.	Peebles.
Burntisland.	Haddington.	Perth.
Campbeltown.	Hamilton.	Peterhead.
Cullen.	Hawick.	Port Glasgow.
Cupar.	Inveraray.	Portobello.
Dingwall.	Inverness.	Queensferry, North.
Dornoch.	Irvine.	Queensferry, South.
Dumbarton.	Jedburgh.	Renfrew.
Dumfries.	Keith.	Rothesay.
Dunbar.	Kilmarnock.	Rutherglen.
Dundee.	Kintore.	Selkirk.
Dunfermline.	Kirkcaldy.	St. Andrews.
Dunse.	Kirkcudbright.	Stirling.
Edinburgh.	Lanark.	Tain.
Elgin.	Leith.	Wick.
Fife.	Lerwick.	Total, 66.

IRELAND.

Athlone.	
Belfast.	
Bray.	
Carrickfergus.	
Coleraine.	
Cork.	
Dalkley.	
Drogheda.	
Dublin.	
Enniskillen.	
Galway.	
Kilkenny.	
Limerick.	
Londonderry.	
Newry.	
Queenstown.	
Sligo.	
Tralee.	
Waterford.	
Wexford.	
Total, 20.	

England and Wales	204
Scotland - -	66
Ireland - -	20
Grand Total -	290

Thie is exclusive of several boroughs, the Town Councils of which are not the Local Authority under the Explosives Act, to which visits have been paid.

APPENDIX O.

Circular.

Home Office, Whitehall, S.W.,
7th December 1893.

Our attention has recently been directed to a narrow escape from explosion on board the barque "Loch Sloy," bound for Adelaide, when lying off Greenock, and being loaded with gunpowder. Ten tons of gunpowder had already been stowed, all lights and fires having been previously extinguished, and the usual precautions taken, when a smell of fire was noticed, and, on examination being made, a fire was discovered at the back of the range in the galley, and this it was ascertained was due to the presence of a small hole in one of the iron plates in the back of the range permitting a flame to pass through and come in contact with the outer wooden lining. Fortunately, in this case, it was possible to extinguish the fire without further consequences, but the circumstance appears to disclose a risk which induces me to address you upon the subject, with a view to the adoption of a slight extra precaution to prevent the occurrence of any such accident on board your magazine. The risk is, that through wear, or through the protecting metal being burnt through, the woodwork in the neighbourhood of the fire on board may be exposed to the impingement of flame, and a fire may thus become established, leading possibly to most serious consequences. I am of opinion, that, in order to avert this risk, it is desirable that one of two precautions should be adopted, viz., either:—

(*a.*) The use of two sheets of iron, or steel, or other suitable metal, instead of one, to protect such woodwork, and, preferentially, these sheets should have a small air space; or

(*b.*) The introduction of a layer of asbestos between the protecting metal and the woodwork.

At present, licenses for floating magazines generally contain a term to the effect that the woodwork in the vicinity of a fire on board such magazine shall be protected by means of a good and sufficient covering of suitable metal. In view of the occurrence which I have described above, Her Majesty's Inspectors of Explosives will not be prepared to accept as sufficient any protective covering which does not satisfy one or other of the conditions (*a.*) or (*b*) which I have set out.

I shall be glad to hear from you within what period you will undertake to carry out the alterations necessary to give effect to this communication.

I have, &c.
(Signed) V. D. Majendie, Colonel,
H.M.'s Chief Inspector of Explosives.

To occupiers of all Floating Magazines.

APPENDIX P.

A List of the more important Outrages and Attempts, and suspicious cases of Discoveries of Explosives (exclusive of scares), which have engaged the attention of Her Majesty's Inspectors of Explosives during the Period 1881–1893, inclusive.

1881.

Salford Barracks. — 14 *January.*—An attempt to blow up the barracks at Salford by dynamite. The injury to the barracks was insignificant, but one boy was killed and another injured. (*See* Annual Report for 1881, page 46.)

Mansion House, London. — 16 *March.*—An attempt to injure the Mansion House, London, by a box containing from 15 to 20 lbs. of gunpowder. The touchpaper by which the gunpowder was to have been fired was extinguished by a policeman. (*Ibid.*, page 47.)

Police Barracks, Liverpool. — 16 *May.*—An attempt to blow up the police barracks at Liverpool with gunpowder in iron piping. The damage to the building was inconsiderable, and no one was hurt. (*Ibid.*, page 48.)

Town Hall, Liverpool. — 10 *June.*—An attempt to blow up the Town Hall, Liverpool, by an infernal machine probably filled with dynamite. A great number of windows were broken, and some iron railings were destroyed, but no one was injured. The two perpetrators were captured. (*Ibid.*, page 47.)

Police Station, Loanhead (Edinburgh). — 14 *June.*—A piece of iron piping filled with gunpowder exploded against the police station at Loanhead, near Edinburgh. Some windows were broken, but no other damage was effected. (*Ibid.*, page 50.)

Importation of infernal machines at Liverpool. — 30 *June.*—An importation of six infernal machines at Liverpool from America in the "Malta," concealed in barrels of cement. They contained lignin dynamite, with a clockwork arrangement for firing it. (*Ibid.*, page 50.)

2 *July.*—An importation of four similar machines at Liverpool in the "Bavaria." (*Ibid.*, page 50.)

Boat at Perth. — 15 *August.*—A large sandboat moored in the Tay at Perth, blown up with dynamite. The perpetrator was convicted and sentenced to 12 months' imprisonment. (*Ibid.*, page 47.)

The Barracks, Castlebar. — 8 *September.*—An attempt to produce an explosion at the barracks, Castlebar. A canister containing gunpowder was thrown over the wall, close to the magazine. The lighted fuze which was attached fell out, and no harm was done. (*Ibid.*, page 47.)

1882.

Edinburgh. — 18 *February.*—Boxes fitted up as infernal machines sent to various persons in Edinburgh, by a man who was afterwards convicted of the offence and sentenced to 20 years' penal servitude. About eight persons were injured. (Annual Report for 1882, page 47.)

Weston House, Galway. — 26 *March.*—An attempt to blow up Weston House, Galway, with dynamite in an iron pot enclosed in a sack. Five persons were afterwards convicted of the outrage. (Annual Report for 1883, page 49.)

Letterkenny. — 27 *March.*—A 6-inch shell charged with explosive thrown into a house in Letterkenny. The explosion caused considerable damage.

Police Barracks, Limerick. — 2 *April.*—An attempt to destroy the police barracks in Limerick by firing some dynamite on the window sill. (Annual Report for 1882, page 47.)

Mansion House, London. — 12 *May.*—A discovery of a parcel containing 12 lbs. to 20 lbs. of gunpowder with lighted touch paper or fuze attached at the Mansion House, London. (*Ibid.*, page 47.)

1883.

*20 *January.*—An explosion of lignin dynamite at Tradeston Gasworks, Glasgow, doing considerable damage. (Annual Report for 1883, page 48; Special Report, No. L., dated 14th March 1883.) — Glasgow Gas Works.

*21 *January.*—An explosion of lignin dynamite at Possil Bridge, Glasgow. Two or three persons passing sustained slight injury. (*Ibid.*) — Possil Bridge, Glasgow.

*21 *January.*—An explosion of lignin dynamite at Buchanan Street Station, Glasgow, in a disused goods shed. (*Ibid.*) — Buchanan Street Station, Glasgow.

15 *March.*—An explosion at the Local Government Board Office, Whitehall, causing considerable local damage. (*Ibid.*, Special Report, No. LI., dated 27th April 1883.) — Local Government Board, Whitehall.

15 *March.*—An abortive explosion of lignin dynamite outside a window at the "Times" office. (*Ibid.*) — Times Newspaper Office.

27 *March.*—Two infernal machines, containing 28 lbs. of lignin dynamite (probably home made), discovered at Liverpool. (*Ibid.*, page 49.) Four persons were convicted and sentenced to penal servitude for life. — Liverpool infernal machines.

5 *April.*—The discovery of a factory of nitro-glycerine at Birmingham, and of a large amount of nitro-glycerine brought thence to London. (Annual Report for 1883, p. 7.) The occupier of the house and others were subsequently convicted and sentenced to penal servitude for life. — Manufacture of nitro-glycerine at Birmingham.

30 *October.*—An explosion in the Metropolitan Railway, between Charing Cross and Westminster, unattended with personal or serious structural injury. (*Ibid.*, page 49; Special Report, No. LV., dated 17th November 1883.) — Underground Railway, Westminster.

30 *October.*—An explosion on the Metropolitan Railway, near Praed Street. Three carriages sustained serious injury, and about 62 persons were cut by the broken glass and débris, and otherwise injured. (*Ibid.*) — Underground Railway, Praed Street.

22 *November.*—Two infernal machines discovered in a house in Westminster, occupied by a German named Woolf. Two men were tried and in the result the jury disagreed and a *nolle prosequi* was entered on behalf of the Crown. (*Ibid.*, page 50.) — Westminster infernal machines.

1884.

16 *January.*—The discovery of some slabs of Atlas Powder A. (American make) in Primrose Hill tunnel. — Primrose Hill Tunnel.

26 *February.*—An explosion in the cloak room of the London, Brighton, and South Coast Railway at Victoria Station of Atlas Powder A. (American make), left in a bag or portmanteau. (Annual Report for 1884, page 37; Special Report, No. LIX., dated 8th March 1884.) — London railway stations; outrages; Victoria.

27 *February.*—The discovery of a bag containing some Atlas Powder A., with clockwork and detonators at Charing Cross Station. (*Ibid.*) — Charing Cross.

28 *February.*—A similar discovery at Paddington Station. (*Ibid.*) — Paddington.

1 *March.*—A similar discovery at Ludgate Hill Station. (*Ibid.*) — Ludgate Hill.

11 *April.*—A discovery of three metal bombs, containing dynamite (probably American make), at Birkenhead, in possession of a man named Daly, who was afterwards sentenced to penal servitude for life. (*Ibid.*, page 38.) — Birkenhead. (Daly's bombs.)

30 *May.*—An explosion of dynamite at the Junior Carlton Club, St. James' Square. About 14 persons were injured. (*Ibid.*, page 38; Special Report, No. LXII., dated 10th June 1884.) — Junior Carlton Club.

30 *May.*—An explosion of dynamite at the residence of Sir Watkin Williams Wynn, St. James' Square. (*Ibid.*) — Sir Watkin Wynne's, St. James' Square.

30 *May.*—An explosion of dynamite in a urinal under a room occupied by some of the detective staff in Scotland Yard. It brought down a portion of the building, besides severely injuring a policeman and some persons who were at an adjacent public house. (*Ibid.*) — Scotland Yard.

30 *May.*—A discovery of Atlas Powder A., with fuze and detonators, in Trafalgar Square. (*Ibid.*) — Trafalgar Square.

* In connexion with these three explosions, 10 persons were subsequently convicted. (*See* Annual Report for 1885.)

1884—*cont.*

Mr. Hussey's House, Edenburn, near Tralee.

28 *November.*—An attempted destruction of a house at Edenburn, near Tralee, occupied by Mr. Hussey. The injury, which was doubtless accomplished with dynamite, was less serious than was intended, and no one sustained bodily harm. (*Ibid.*, Special Report, No. LXVIII., dated 5th December 1884.)

London Bridge.

13 *December.*—An explosion of a large charge of dynamite or other nitro-compound under London Bridge, fortunately doing very little damage. (*Ibid.*)

1885.

Explosion in Underground Railway (Gower Street).

2 *January.*—An explosion in the Gower Street tunnel of the Metropolitan Railway, caused by about 2 lbs. of some nitro-compound fired apparently by a percussion fuze. Damage inconsiderable.

Explosion at Tower of London.

24 *January.*—An explosion in the Tower of London, caused, beyond all reasonable doubt, by about 5 to 8 lbs. of Atlas Powder A. (American make). Three or four persons were slightly injured and considerable damage was done to the Armoury. (Annual Report for 1885, page 59).

Westminster Hall.

24 *January.*—An explosion of a similar amount of Atlas Powder A. (American make), in Westminster Hall. Three persons were injured severely, and others slightly, and very considerable damage was done to the Hall and surroundings. (*Ibid.*, page 59.)

House of Commons.

24 *January.*—An explosion in the House of Commons (probably caused by a similar amount of the same explosive). No persons were injured, but very considerable damage was done to the Houses of Parliament. (*Ibid.*, page 59.)

In connexion with these three last-named outrages two men (Burton and Cunningham) were afterwards convicted and sentenced to penal servitude for life.

Harrow Road.

10 *February.*—A discovery of dynamite (of American make), in a house in Harrow Road, Paddington.

Bootle.

9 *March.*—A discovery of Atlas Powder A. in the roof of a sawmill at Bootle.

Admiralty.

23 *April.*—Explosion of an infernal machine containing gunpowder, at Admiralty, Whitehall. Mr. Swainson, in whose room the explosion occurred, sustained severe injuries, and the room and neighbouring apartments were much damaged. (*Ibia.*, page 59.)

1886.

South Medomsley Colliery, Durham.

24 *March.*—Attempted injury with blasting gelatine to the house of Mr. Tyzack, manager of the South Medomsley Colliery, Durham. (Annual Report for 1886, page 41.)

Callington.

23 *June.*—An attempted injury, by explosion of dynamite, of new reservoir in connection with some new waterworks at Callington. (*Ibid.*)

Londonderry.

12 *July.*—Bottles filled with gunpowder thrown among the crowd at an Orange demonstration at Derry. (*Ibid.*)

Limerick.

1 *September.*—Two attempts to injure residents by means of an iron pipe charged with powder and fuzed. (*Ibid.*)

1887.

Dudley.

27 *January.*—Injury to three shops at Dudley by malicious explosion of gunpowder. (Annual Report for 1887, page 45.)

Harlech.

1 *January.*—An explosion maliciously effected (by means probably of guncotton or dynamite) in the streets of Harlech. (*Ibid.*, page 46.)

Kildysart, co. Clare.

17 *February.*—Attempted dynamite outrage at Paradise House, near Kildysart, Co. Clare (the residence of the Recorder of Galway). (*Ibid.*, page 45.)

Walton, near Preston.

20 *March.*—Injury to a man at Walton, near Preston, by an infernal machine. (*Ibid.*, page 45.)

Preston.

8 *March.*—Attempted injury by tonite to canal near Preston. (*Ibid.*, page 44.)

Newcastle. West.

21 *April.*—Malicious explosion of gunpowder at house at Newcastle, West, occupied by Mr. John Murphy. (*Ibid.*, page 45.)

Hebburn.

4, 21, and 24 *May.*—Three outrages with explosives at Hebburn, Durham. (*Ibid.*)

Llanerchymedd.

27 *July* —Attempt to injure the police station at Llanerchymedd by means of gunpowder. (*Ibid.*)

1887—*cont.*

16 *August.*—Attempt to injure railway bridge at Ennis with dynamite. (*Ibid.*) — Ennis.

23 *October.*—Malicious explosion at the house of County Inspector Ridge, Royal Irish Constabulary, at Cavan. (*Ibid.*, page 44.) — Cavan

20 *November.*—Discovery of conspiracy between Callan and Harkins to commit an outrage or outrages by means of dynamite. (*Ibid.*, page 46.) — Case of Callan and Harkins.

6 *December.*—Attempt to injure the residence of the High Sheriff of Kerry, at Listowel. (*Ibid.*, page 45.) — Listowel.

16 *December.*—Explosion of an infernal machine on the premises of a person at Macroom who had offended the Land League. (*Ibid.*) — Macroom.

16 *April.*—Explosion of gunpowder on the premises of a Mr. William Maddocks, contractor, Birkenhead, probably intended to cause alarm rather than real damage. (*Ibid.*) — Birkenhead.

August.—An outrage was perpetrated at Bodvain Rectory, Denbighshire, by exploding some substance against a window. (*Ibid.*, page 46.) — Bodvain Rectory (Denbighshire).

1888.

18 and 23 *February*, 18 *September*, and 6 *December.*—Five minor outrages or suspicious circumstances suggesting intended attempts at explosive outrages in Ireland—at Ennis, Listowel, Letterkenny, Coleraine, and Skibbereen. (Annual Report for 1888, page 44.) — Ireland.

29 *April.*—A small charge of gunpowder was exploded close to a new small-pox hospital, Trooper's Hill, St. George, Gloucestershire. (*Ibid.*) — Trooper's Hill, St. George, Gloucestershire.

1889.

7 *September.*—Explosion of an infernal machine in Mr. Smith-Barry's office, near Tipperary. (Annual Report for 1889, page 41.) — Tipperary.

18 *November.*—Attempt, by means of an infernal machine, to blow up the police and bailiffs engaged in carrying out evictions on Lord Clanricarde's estate near Woodford, co. Galway. (*Ibid.*, page 40.) — Near Woodford, co. Galway.

28 *November.*—Attempt to explode infernal machine at Rochdale School Board Office. (*Ibid.*, page 41.) — Rochdale.

1890.

27 *January.*—Explosion of infernal machine in main street of Macroom. (Annual Report for 1890, page 41.) — Macroom.

22 *March.*—Destruction of a hut at a railway crossing near Toome station, co. Antrim, by malicious explosion. (*Ibid.*) — Toome, co. Antrim.

17 *July.*—Attempt to do injury or to create alarm by means of an infernal machine at the Falmouth Custom House. (*Ibid.*) — Falmouth.

25 *September.*—Explosion of a stone jar filled with gunpowder on window sill of a surgery occupied by Chairman of Town Commissioners, Tipperary. (*Ibid.*, page 42.) — Tipperary.

9 *October.*—Attempted outrage, by means of blasting powder, on the premises of a baker at Templecombe. (*Ibid.*) — Templecombe.

1891.

15 *January.*—Malicious injury, by explosion, to the Dawsholm Gasworks, near Glasgow. (Annual Report for 1891, page 40.) — Glasgow.

3 *July.*—Personal outrage, by the explosion of a detonator, to a woman in the streets of Sunderland. (*Ibid.*) — Sunderland.

25 *October.*—Injury to offices of "National Press," in Dublin, by means of an explosive thrown into the building. (*Ibid.*) — Dublin.

1891—*cont.*

Croscombe. 5 *November.*—Malicious explosion of tonite in the house of a police constable, and other houses at Croscombe, Somerset. (*Ibid.*)

Dublin Castle. 31 *December.*—Malicious explosion in the offices of the Chief Secretary, Dublin Castle. (*Ibid.*, page 39.)

Dublin Post Office. *December.*—Discovery of a packet of dynamite, with fuze, in the Dublin Post Office. (*Ibid.*)

1892.

Bristol. 29 *January.*—Explosion of infernal machine at private residence near Bristol. (Annual Report for 1892, page 53.)

Walsall anarchists. 24 *March.*—Conviction of anarchists at Walsall for being in possession of explosives for unlawful purposes, under Explosive Substances Act, 1883. (*Ibid.*, page 53.)

Castle Eden Colliery. 5 *April.*—Explosion of infernal machine during Durham mining strike at house at Castle Eden Colliery. (*Ibid.*, page 53.)

Inverkeithing. 5 *June.*—Explosion of dynamite or gelatine cartridge in doorway of house at Inverkeithing. (*Ibid.*, page 54.)

Rathkeale. 5 *August.*—Explosion of a quantity of gunpowder on window-sill of an hotel at Rathkeale. (*Ibid.*, page 54.)

Spennymoor. 12 *August.*—Explosion of a quantity of gunpowder in a miner's house at Low Spennymoor. (*Ibid.*, page 54.)

Dublin Castle. 24 *December.*—Explosion of infernal machine outside the Detective Office in Exchange Court. One detective officer was killed. (*Ibid.*, page 53.)

1893.

Monmouth. 19 *April.*—Discovery of a tin can containing about 10½ lbs. of gunpowder, with an arrangement for exploding it, on the line at the Newport end of the Gair tunnel.

Four Courts, Dublin. 6 *May.*—Explosion of an infernal machine at the Four Courts, Dublin, situated on the north bank of the Liffey, at Inns Quay.

Broadstairs, Kent. 22 *July.*—Death of a man at Broadstairs, from the explosion of an infernal machine which had been sent to him by post.

Great Bridge, Staffordshire. 28 *July.*—Explosion of a detonator in a public-house at Great Bridge, causing serious injury to three men.

Chorley, Lancashire. 27 *August.*—A cartridge, probably of tonite, was thrown into the garden of a farmhouse at Euxton causing damage to windows.

Parr, near St. Helen's. 17 *September.*—The house of a colliery fireman at Parr was wrecked by the explosion of some explosive, probably roburite.

St. George's Cathedral, London. 1 *October.*—Explosion, without injury, of some unknown substance during the service at St. George's (Roman Catholic) Cathedral.

Broad Oak Road, Parr. 20 *October.*—Explosion of roburite on window-sill of a house occupied by a colliery fireman at Broad Oak Road, Parr.

Ovingham, Northumberland. 27 *October.*—Explosion of some substance placed on the window-sill of a house occupied by a gamekeeper, at Ovingham.

Aldborough Barracks, Dublin. 26 *November.*—Discovery of a tin box containing dynamite, with fuze attached, at Aldborough Barracks, Dublin.

Dalziel, Lanarkshire. 10 *December.*—An explosion of a malicious character outside the dwelling-house of a gasman, in Cowies Square, Craigneuk, Dalziel.

APPENDIX Q.

THE following SPECIAL REPORTS have been issued since the Act came into operation.

No.	Subject.	Date of Accident.	Date of Report.
I.	Report on the circumstances attending an Explosion of Dynamite at Cymmer, Glamorganshire (by Major Majendie, R.A.).	21 April 1876 -	24 May 1876.
II.	Report on the circumstances attending an Explosion of gunpowder at a Gunpowder Factory at Herodsfoot, Liskeard, Cornwall (by Major Majendie, R.A.).	12 May 1876 -	26 May 1876.
III.	Report on the circumstances attending an Explosion of Fulminate of Mercury at Hinks' Chemical Works, Small Heath, Birmingham (by Major Ford, R.A.).	14 May 1876 -	6 June 1876.
IV.	Report on the circumstances attending an Explosion of Dynamite at Burnbank, near Hamilton, N.B. (by Major Majendie, R.A.).	19 June 1876 -	1 September 1876.
IVA.	Report on the circumstances attending an Explosion of Fireworks at Norwich (by Major Majendie, R.A.).	12 September 1876	10 October 1876.
V.	Report on the circumstances attending an Explosion of Gunpowder at a Gunpowder Factory at Herodsfoot, Liskeard, Cornwall (by Major Ford, R.A.).	14 October 1876 -	9 November 1876.
VI.	Report on the circumstances attending an Explosion of Gunpowder at Hose Tunnel, near Scalford (by Major Ford, R.A.).	14 October 1876 -	21 December 1876.
VII.	Report on the circumstances attending an Explosion of Tonite or Cotton Powder in a tunnel near Festiniog (by Major Majendie, R.A.).	26 January 1877 -	7 March 1877.
VIII.	Report on the circumstances attending an Explosion of a Floating Magazine moored on the River Thames below Gravesend (by Major Majendie, R.A.).	30 June 1877 -	10 August 1877.
IX.	Report on the circumstances attending an Explosion in the Factory of the Schultze Gunpowder Company (Limited), at Eyeworth, Hants (by Major Majendie, R.A.).	8 August 1877 -	1 September 1877.
X.	Report on the circumstances attending an Explosion of Gunpowder at No. 57, High Street, Bedford (by Major Ford, R.A.).	28 August 1877 -	24 September 1877.
XI.	Report on the circumstances attending an Explosion in a tunnel near Festiniog (by Major Ford, R.A.).	23 August 1877 -	29 September 1877.
XII.	Report on the circumstances attending an Explosion in the Factory of the Schultze Gunpowder Company (Limited), at Eyeworth, Hants (by Major Majendie, R.A.).	12 November 1877	24 December 1877.
XIII.	Report on the circumstances attending an Explosion in the Detonator Factory of the Cotton Powder Company (Limited), at Uplees Marshes, near Faversham (by Major Majendie, R.A.).	12 February 1878	6 March 1878.
XIV.	Report on the circumstances attending an Explosion in a Tunnel in course of construction at Halkyn, near Holywell (by Major Ford, R.A.).	10 April 1878 -	28 June 1878
XV.	Report on the circumstances attending two Explosions at Yarlside Mines, Parkhouse, Barrow-in-Furness (by Major Ford, R.A.).	14 May and 3 July 1878.	27 July 1878.
XVI.	Report on the circumstances attending an Explosion by Lightning of a Gunpowder Store at Victoria Colliery, Bruntcliffe (by Major Majendie, R.A.).	6 August 1878 -	17 September 1878.
XVII.	Report on the circumstances attending an Explosion in Mr. MacDonald's War Rocket Factory at Whitehill, near Gravesend (by Major Majendie, R.A.).	13 September 1878	30 September 1878.
XVIII.	Report on the circumstances attending an Explosion of Dynamite in Carn Brea Mine, Redruth (by Major Majendie, R.A.).	27 September 1878	30 October 1878.

No.	Subject.	Date of Accident.	Date of Report.
XIX.	Report on the circumstances attending an Explosion of Gunpowder at a Gunpowder Factory at Elterwater, near Ambleside, Westmoreland (by Major Ford, R.A.).	29 November 1878	28 December 1878.
XX.	Report on the circumstances attending an Explosion of Dynamite at Deep Level Mine, Halkyn, near Holywell (by Major Ford, R.A.).	9 January 1879 -	12 February 1879.
XXI.	Report on the circumstances attending an Explosion of the Press House of Mr. Sharp's Gunpowder Factory at Chilworth, near Guildford (by Major Majendie, R.A.).	10 February 1879	20 February 1879.
XXII.	Report on the circumstances attending an Explosion of a Glazing House in Messrs. Hall's Gunpowder Factory at the Marsh, Faversham (by Major Majendie, R.A.).	21 February 1879	17 March 1879.
XXIII.	Report on the circumstances attending an Explosion of Gunpowder in the Extracting House of the Gunpowder Factory of Messrs. Pigou, Wilks, & Laurence (Limited), at Dartford (by Major Majendie, R.A.).	11 March 1879 -	31 March 1879.
XXIV.	Report on the circumstances attending an Accident which occurred in the Detonator Factory of Nobel's Explosives Company (Limited), at Redding, West Quarter, near Falkirk (by Major Majendie, R.A.).	12 May 1879 -	24 May 1879.
XXV.	Report on the circumstances attending an Explosion which occurred in the Detonator Factory of the Cotton Powder Company (Limited), at Uplees Marshes, near Faversham (by Major Ford, R.A.).	16 May 1879 -	23 June 1879.
XXVI.	Report on the circumstances attending an Accident in the use of Dynamite in a Tunnel in course of construction under the River Severn (by Major Ford, R.A.).	23 September 1879	30 October 1879.
XXVII.	Report on the circumstances attending an Explosion of Gunpowder at a House at Pentre, Broughton, near Wrexham (by Major Ford, R.A.).	30 October 1879 -	19 November 1879.
XXVIII.	Report on the circumstances attending an Explosion which occurred in the Detonator Factory of Nobel's Explosives Company (Limited), at Redding, West Quarter, near Falkirk (by Major Majendie, R.A.).	13 October 1879 -	26 November 1879.
XXIX.	Report on the circumstances attending an Explosion of Gunpowder in Doncaster (by Major Majendie, R.A.).	3 January 1880 -	23 January 1880.
XXX.	Report on the circumstances attending an Explosion of Nitro-Glycerine (from Dynamite), at a Railway Cutting at Craig, near Montrose (by Major Ford, R.A.).	5 March 1880 -	30 March 1880.
XXXI.	Report on the circumstances attending an Explosion of Gunpowder in a Glazing House at Messrs. John Hall & Son's Gunpowder Factory at the Marsh, Faversham (by Lieut.-Col. Majendie, C.B., R.A.).	11 December 1880	21 February 1881.
XXXII.	Report on the circumstances attending an Explosion of Gunpowder and Blasting Cartridges at Messrs. John Hall & Son's Cartridge Factory at Eastwood, near Nottingham (by Major Ford, R.A.).	14 January 1881 -	9 March 1881.
XXXIII.	Report on the circumstances attending an Explosion of Gunpowder at a Gunpowder Factory at Blackbeck, Haverthwaite, Lancashire (by Lieut.-Col. Majendie, C.B., R.A.).	19 March 1881 -	5 April 1881.
XXXIV.	Report on the circumstances attending an Explosion of Dynamite and Blasting Gelatine in the Minera Mines, near Wrexham (by Lieut.-Col. Majendie, C.B., R.A.).	23 March 1881 -	14 May 1881.
XXXV.	Report on the circumstances attending an Explosion of Dynamite on the River Clyde, off Gravel Point, near Greenock (by Major Ford, R.A.).	16 April 1881 -	17 May 1881.
XXXVI.	Report on the circumstances attending an Explosion in Messrs. C. T. Brock & Co.'s Firework Factory at South Norwood (by Lieut.-Col. Majendie, C.B., R.A.).	24 May 1881 -	15 July 1881.

No.	Subject.	Date of Accident.	Date of Report.
XXXVII.	Report on the circumstances attending an Explosion of Gunpowder at a Press-house of a Gunpowder Factory at Gatebeck, near Kendal (by Major Ford, R.A.).	21 July 1881 -	11 August 1881.
XXXVIII.	Report on the circumstances attending an Explosion at a small Firework Factory at Nechells' Park Road, Birmingham (by Major Ford, R.A.).	17 August 1881 -	15 October 1881.
XXXIX.	Report on the circumstances attending the Burning and Explosion of a quantity of Fireworks in a Dwelling-house in Hanley (by Colonel Majendie, C.B.).	6 March 1882 -	19 June 1882.
XL.	Report on the circumstances attending an Explosion on Premises occupied by Mr. William Riley, Albumen Manufacturer, Drysalter, &c., in Henry Street, Castleton, near Manchester (by Captain Cundill, R.A.).	19 April 1882 -	20 June 1882.
XLI.	Report on the circumstances attending an Explosion in the Factory of Nobel's Explosives Company (Limited), at Ardeer, near Stevenston, in Ayr (by Captain Cundill, R.A.).	8 June 1882 -	29 June 1882.
XLII.	Report on the circumstances attending an Explosion at the Hull Botanic Gardens (by Captain Cundill, R.A.).	25 September 1882	6 November 1882.
XLIII.	Report on the circumstances attending an Explosion of Wet Tonite or Cotton Powder during the operation of pressing the same into Blasting Cartridges at the Works of the Cotton Powder Co. (Limited), at Uplees Marshes, near Faversham (by Colonel Majendie, C.B.).	5 November 1882 -	30 November 1882.
XLIV.	Report on the circumstances attending an Explosion in the Factory of Nobel's Explosives Company (Limited), at Ardeer, Ayrshire (by Captain Cundill, R.A.).	27 October 1882 -	9 December 1882.
XLV.	Report on the circumstances attending an Explosion in the Factory of the Potentite Company (Limited), at Melling, near Liverpool (by Lieut.-Col. Ford, R.A.).	15 July 1882 -	28 November 1882.
XLVI.	Report on the circumstances attending an Explosion which occurred during the Manufacture of Fog Signals at Messrs. Dyer & Robson's Ammunition Factory in Greenwich Marshes (by Colonel Majendie, C.B.).	28 November 1882	8 December 1882.
XLVII.	Report on the circumstances attending an Explosion at the Askham Iron Furnaces near Barrow-in-Furness (by Captain Cundill, R.A.).	8 December 1882 -	30 December 1882.
XLVIII.	Report on the circumstances attending two Explosions at the Factory of the Explosives Company (Limited), at Pembrey Burrows, Carmarthenshire (by Colonel Majendie, C.B.).	11 and 17 November 1882.	19 January 1883.
XLIX.	Report on the circumstances attending an Explosion in the Factory of the Potentite Company (Limited), at Conscough Bridge, near Melling, in Lancashire (by Captain Cundill, R.A.).	26 January 1883 -	10 March 1883.
L.	Report on the circumstances attending three Explosions in Glasgow (by Colonel Majendie, C.B.).	20 and 21 January 1883.	14 March 1883.
LI.	Report on the circumstances attending two Explosions in London at the Offices of the Local Government Board in Whitehall, and of the "Times" Newspaper in Play House Yard respectively (by Colonel Majendie, C.B.).	15 March 1883 -	27 April 1883.
LII.	Report on the circumstances attending an Explosion of Gunpowder and Blasting Cartridges at the Factory of the New Sedgwick Gunpowder Company (Limited), at Sedgwick, near Kendal (by Lieut.-Col. Ford, R.A.).	12 April 1883 -	30 April 1883.
LIII.	Report on the circumstances attending an Explosion by lightning at the Bassinghyll Gunpowder Mills (by Captain Cundill, R.A.).	15 June 1883 -	30 June 1883.
LIV.	Report on the circumstances attending an Explosion at the James Watt Dock, Greenock (by Colonel Ford).	16 August 1883 -	19 September 1883.
LV.	Report on the circumstances attending two Explosions on the Underground Railway, London (by Colonel Majendie, C.B., and Captain Cundill, R.A.).	30 October 1883 -	17 November 1883.

No.	Subject.	Date of Accident.	Date of Report.
LVI.	Report on the circumstances attending an Explosion at the Gunpowder Factory of Messrs. John Hall & Son, at Furnace, Lochfyne, near Inveraray (by Colonel Ford).	29 September 1883	5 December 1883.
LVII.	Report on the circumstances attending an Explosion at the Chilworth Gunpowder Factory (by Colonel Majendie, C.B.).	15 November 1883	5 December 1883.
LVIII.	Report on the circumstances attending an Explosion of Dynamite at the Town Hill Colliery, Dunfermline (by Colonel Majendie, C.B.).	17 December 1883	31 December 1883.
LIX.	Report on the circumstances attending an Explosion of Dynamite at the Victoria Railway Station, Pimlico, and attempted Explosions at the Charing Cross, Paddington, and Ludgate Hill Railway Stations (by Colonel Majendie, C.B., and Colonel Ford).	26 February 1884	8 March 1884.
LX.	Report on the circumstances attending an Explosion on Board the Steamer "Aberdeen," off Gravesend (by Major Cundill, R.A.).	1 March 1884 -	13 March 1884.
LXI.	Report on the circumstances attending an Explosion of Dynamite in a Cartridge Hut at the Factory of Nobel's Explosives Company (Limited), at Ardeer, Ayrshire (by Colonel Ford).	8 May 1884 - -	31 May 1884.
LXII.	Report on the circumstances attending Explosions of Dynamite in Scotland Yard and St. James' Square, and an attempted Explosion in Trafalgar Square (by Colonel Majendie, C.B., and Colonel Ford).	30 May 1884 -	10 June 1884.
LXIII.	Report on the circumstances attending an Explosion at a small Firework Factory at Wisbech (by Major Cundill, R.A.).	23 June 1884 -	5 July 1884.
LXIV.	Report on the circumstances attending an Explosion of Gunpowder at a Gunpowder Factory at Blackbeck, Haverthwaite, Lancashire (by Colonel Ford).	26 July 1884 -	30 August 1884.
LXV.	Report on the circumstances attending an Explosion on board a Steamer off Bournemouth (by Colonel Majendie, C.B.).	20 August 1884 -	17 September 1884.
LXVI.	Report on the circumstances attending an Explosion at the Worsborough Dale Gunpowder Factory (by Colonel Ford).	15 October 1884 -	23 October 1884.
LXVII.	Report on the circumstances attending an Explosion on Premises occupied by Mr. Joseph Balkwill, Chemist and Druggist, at Kingsbridge, Devon (by Major Cundill, R.A.).	30 October 1884 -	10 November 1884.
LXVIII.	Report on the circumstances attending an Explosion at Edenburn, the Private Residence of Mr. S. M. Hussey, in the county of Kerry (by Colonel Ford).	28 November 1884	5 December 1884.
LXIX.	Report on the circumstances attending an Explosion at Larne (by Major Cundill, R.A.).	5 February 1885 -	19 February 1885.
LXX.	Report on the circumstances attending an Explosion at Mr. Jas. Pain's Firework Factory, near Mitcham (by Major Cundill, R.A.).	16 May 1885 -	29 May 1885.
LXXI.	Report on the circumstances attending an Explosion at the Roslin Gunpowder Mills, near Edinburgh (by Major Cundill, R.A.).	9 July 1885 - -	27 July 1885.
LXXII.	Report on the circumstances attending an Explosion at the Gunpowder Factory of Messrs. Pigou, Wilks, and Laurence (Limited), at Dartford (by Colonel Majendie, C.B.).	21 August 1885 -	5 September 1885.
LXXIII.	Report on the circumstances attending an Explosion of Dynamite at the Mancetter Bridge Quarry, near Atherstone, Warwickshire (by Major Cundill, R.A.)	12 January 1886 -	30 January 1886.
LXXIV.	Report on the circumstances attending an Accident from the effects of fired Gunpowder, which occurred at Crarae Quarry, Loch Fyne (by Colonel Ford).	25 September 1886	12 November 1886.
LXXV.	Report on the circumstances attending an Explosion which took place at the Factory of Messrs. Kynoch & Co. (Limited), near Birmingham (by Major Cundill, R.A.)	2 November 1886	29 November 1886.
LXXVI.	Report on the circumstances attending an Accident at a display of Fireworks at Batley (by Major Cundill, R.A.).	24 December 1886	31 December 1886.

No.	Subject.	Date of Accident.	Date of Report.
LXXVII.	Report on the circumstances attending an Explosion of Gunpowder at 134, High Street, Cradley Heath, co. Stafford, on the Registered Premises of Henry Mould, Ironmonger (by Major Cundill, R.A.).	7 April 1887 -	28 April 1887.
LXXVIII.	Report on the circumstances attending an Explosion which occurred in the Lower Glazing House of the Gunpowder Factory of Messrs. Curtis's and Harvey, at Hounslow (by Colonel Ford).	3 May 1887 -	31 May 1887.
LXXIX.	Report on the circumstances attending an Explosion which occurred at the Firework Factory of Mr. John Hodsman, at Love Lane West, Dublin (by Colonel Ford).	24 May 1887 -	19 July 1887.
LXXX.	Report on the circumstances attending an Explosion of Fireworks at Messrs. Dyer and Robson's Factory, in Greenwich Marshes (by Colonel Majendie, C.B.).	11 June 1887 -	30 June 1887.
LXXXI.	Report on the circumstances attending a Fire and Explosion at Messrs. Roberts, Dale, and Company's Chemical Works, Cornbrook, near Manchester (by Colonel Majendie, C.B.).	22 June 1887 -	15 August 1887.
LXXXII.	Report on the circumstances attending an Explosion which took place in an Incorporating Mill at Lowood Gunpowder Works (by Major Cundill, R.A.).	6 September 1887	13 September 1887.
LXXXIII.	Report on the circumstances attending an Explosion of Gunpowder in a Press-house of the Kennall Vale Gunpowder Factory (by Major Cundill, R.A.).	7 November 1887	19 November 1887.
LXXXIV.	Report on the circumstances attending an Explosion of Gunpowder and Blasting Cartridges which occurred at the Factory of Messrs. Williamson & Co. (Limited), at Fernilee, near Whaley Bridge (by Major Cundill, R.A.).	21 March 1888 -	19 April 1888.
LXXXV.	Report on the circumstances attending an Explosion of Percussion Caps (Primers) at the Factory of Messrs. G. Kynoch & Co. (Limited), at Witton, near Birmingham (by Major Cundill, R.A.).	3 July 1888 -	31 July 1888.
LXXXVI.	Report on the circumstances attending an Explosion during the emptying of some 3-pr. Shells for Quick-firing Ammunition at Messrs. Kynoch & Co.'s (Limited) Ammunition Factory, at Witton, near Birmingnam (by Colonel Majendie, C.B.).	10 August 1888 -	22 August 1888.
LXXXVII.	Report on the circumstances attending an Explosion of Amorces or Toy-Caps in the Small Firework Factory of Mr. H. J. Cadwell, at Southfields, Wandsworth (by Major Cundill, R.A.).	3 August 1888 -	12 September 1888.
--	Report on the circumstances attending the destruction of the petroleum vessel "United" in Bristol Docks (by Colonel Majendie, C.B.).	21 November 1888	21 December 1888.
LXXXVIII.	Report on the circumstances attending an Explosion which occurred at Mr. James Pain's Firework Factory, near Mitcham (by Colonel Majendie, C.B.).	4 June 1889 -	22 June 1889.
LXXXIX.	Report on the circumstances attending an Explosion which occurred during the illegal manufacture of Quick-Firing Ammunition by Sir W. G. Armstrong, Mitchell, & Co. (Limited), of Elswick, in the Wherry "Fanny," on the River Tyne (by Colonel Ford).	3 October 1889 -	15 October 1889.
—	Report on the circumstances attending an Explosion of Gunpowder at a Cartridge Factory in the occupation of M. Ferdinand Corvilain, and a Fire of Petroleum which resulted therefrom, at Antwerp (by Colonel Ford).	6 September 1889	1 October 1889.
XC.	Report on the circumstances attending an Explosion of Detonators which occurred at the Factory of Nobel's Explosives Company (Limited), at Redding, West Quarter, near Falkirk (by Colonel Ford).	15 November 1889	28 December 1889.
XCI.	Report on the circumstances attending an Explosion of Gunpowder which occurred at the Roslin Gunpowder Factory, near Edinburgh (by Colonel Ford).	22 January 1890 -	17 February 1890.

No.	Subject.	Date of A	Date of Report.
XCII.	Report on the circumstances attending an Explosion of Nitro-Glycerine exuded from Dynamite, at the Colwill Quarry, near Egg-Buckland, Devonshire (by Major Cundill, R.A.).	18 February 1890 -	3 March 1890.
XCIII.	Report on the circumstances attending an Explosion which occurred at the Grin Quarries, Burbage, near Buxton (by Colonel Majendie, C.B.).	1 March 1890 -	25 March 1890.
XCIV.	Report on the circumstances attending an Explosion of Fireworks at Mr. James Pain's Firework Factory, near Mitcham (by Colonel Majendie, C.B.).	6 July 1890 -	24 July 1890.
XCV.	Report on the circumstances attending an Explosion of Gunpowder which occurred at the Gunpowder Factory at Roslin, near Edinburgh (by Colonel Ford).	22 October 1890 -	12 November 1890.
XCVI	Report on the circumstances attending an Explosion of Gunpowder which occurred at the Kames Gunpowder Factory (by Lieut.-Colonel Cundill, R.A.).	11 September 1891	26 September 1891.
XCVII.	Report on the circumstances attending an Explosion of Fireworks which occurred on board a Floating Magazine below Gravesend (by Colonel Majendie, C.B.).	11 January 1892 -	1 February 1892.
XCVIII.	Report on the circumstances attending Ignition and Partial Explosion of Gelatine Dynamite at Nant-y-Mwyn Lead Mine, Carmarthenshire (by Lieut.-Colonel Cundill).	28 March 1892 -	19 April 1892.
XCIX.	Report on the circumstances attending an Explosion in small Firework Factory at Coseley (by Lieut. Colonel Cundill).	6 August 1892 -	19 August 1892.
C.	Report on the circumstances attending an Explosion on Board the "Auchmountain" on the River Clyde (by Lieut.-Colonel Cundill).	3 September 1892	12 September 1892.
CI.	Report on the circumstances attending an Explosion at Roslin Gunpowder Factory (by Colonel Majendie, C.B.).	17 September 1892	31 October 1892.
CII.	Report on the circumstances attending an Explosion at a small Firework Factory at Barton Moss, near Manchester (by Lieut.-Colonel Cundill).	26 October 1892 -	1 November 1892.
CIII.	Report on the circumstances attending an Explosion in Messrs. C. T. Brock & Co.'s Firework Factory at South Norwood (by Colonel Majendie, C.B.).	13 March 1893 -	24 April 1893.
CIV.	Report on the circumstances attending the destruction by Explosion and Fire of a Drying-House at the Factory of the Smokeless Powder Co., Limited (by Colonel Majendie, C.B.).	26 May 1893 -	20 June 1893.
CV.	Report on the circumstances attending an Explosion which occurred at Messrs. C. T. Brock & Co.'s Firework Factory at South Norwood (by Captain Thomson, R.A.).	19 August 1893 -	9 September 1893.
CVI.	Report on the circumstances attending an Explosion of Dynamite which occurred at Sutton Harbour, Plymouth (by Captain Thomson, R.A.).	13 December 1893	18 December 1893.
CVII.	Report on circumstances attending an Explosion which occurred at the Ammunition Factory of Messrs. F. Joyce & Co., Limited, at Waltham Abbey (by Colonel Majendie, C.B.).	22 December 1893	30 December 1893.

APPENDIX R.

EXPLOSIVES ACT, 1875. (38 Vict. cap. 17.)

MEMO.

Home Office, Whitehall, S.W.,
January 1, 1888.

When an inventor desires a new Explosive to be placed on the list of "Authorized Explosives" with a view to its being ultimately licensed for manufacture or importation, the steps to be taken are as follows:—

(*a.*) The inventor (or his agent) must write stating (confidentially if preferred) the exact composition of the explosive he proposes to submit* and the name by which it is to be distinguished.

This done, the applicant will be informed as to the amount of fee payable for the examination of the same under the scale of fees laid down by the Secretary of State. This fee will then have to be deposited at the Home Office and will *not* be returned whether the result of the examination is or is not favourable to the introduction of the explosive.

(*b.*) The inventor will then be asked to submit samples (the required amount being stated), and when he reports them ready a special permit for their conveyance will be sent to him.†

(*c.*) The general result of the examination will be communicated to the inventor. If it is found that the explosive is likely to be reasonably safe under ordinary conditions of manufacture, transport, and use, and especially that it is not too sensitive to friction or percussion, or a combination of these, an application for a license to manufacture or import the same will be entertained.

If, however, the explosive fails to comply with the above conditions, it will not be placed on the list of authorised explosives.

V. D. MAJENDIE, Colonel,
H.M. Chief Inspector of Explosives.

APPENDIX S.

LOCAL GOVERNMENT (SCOTLAND) ACT, 1889.

Explosives Act, 1875.

Circular No. 186.

Office of the Secretary for Scotland.
Whitehall, S.W., December 11, 1893.

SIR,

THE attention of the Secretary for Scotland has been drawn by the Secretary of State for the Home Department to the advantages to be derived from concentration as opposed to distribution of jurisdiction in the administration of the Explosives Act, 1875.

Having due regard to this expression of opinion by the Secretary of State, within whose jurisdiction the matter rests, I am directed by the Secretary for Scotland to suggest, for the consideration of your County Council, that, in concert with the magistrates and commissioners of police burghs who are now the local authority for the purposes of administering the provisions of the aforesaid Act within their respective burghs, they might with advantage avail themselves of section 76 of the Local Government (Scotland) Act, 1889, which provides for action through a joint committee of a county council and the burghs and police burghs therein.

I am to add that the Secretary for Scotland has addressed *mutatis mutandis* a similar communication to the police burghs upon this important matter; and he trusts that the county council will be so good as to give the subject their favourable consideration, with a view to the continued efficient administration of the Explosives Act, 1875, in Scotland.

I am, Sir,
Your obedient Servant,
COLIN SCOTT MONCRIEFF.

The County Clerk of .

* A copy of the Patent Specification should be sent where practicable.
† When the samples have to be imported from abroad, an Importation License will be required.

APPENDIX T (*a*).

PROSECUTIONS—(Government Cases).

Date of Hearing.	Place of Hearing.	Name of Offender.	Act under which Proceedings were taken.	Number of Information.	Nature of Offence.	Result of Hearing.	Amount of Penalty.	Amount of Costs.	Amount of Forfeiture or Penalty in lieu.	Remarks.
1893.							£ s. d.	£ s. d.	£ s. d.	
10 April -	Conway -	Richard Cokburne Briscoe, 19, Old Hall Street, Liverpool.	Explosives Act, 1875.	1	Importing explosive not in accordance with the terms of his importation license.	Convicted -	25 0 0	13 9 3	—	
13 May -	Dartford Petty Sessions Court.	Maxim-Nordenfelt Guns and Ammunition Company, Limited, 32, Victoria St., S.W. (Factory 47, Kent.)	Do. -	1	Not complying with order of Secretary of State as to packing.	Dismissed (without costs).	—	—	—	
				2	Breach of terms of license as to packing explosives.	Convicted -	10 0 0	5 5 0 (exclusive of court costs).	—	These proceedings arose out of Accident 8, 1893.
3 August -	South-Western Police Court, S.W.	Joseph Wells, Riversdale Works, Earlsfield, S.W. (Factory 57, Surrey.)	Do. -	1	Packing fireworks outside his factory magazine	Do. -	20 0 0	5 5 0	—	
				2	Not conveying explosive in the factory with due diligence.	Do. -	10 0 0			
				3	Exposed iron nails in floor of danger building M.	Do. -	10 0 0			
				4	Having explosive not in use in an uncovered receptacle.	Do. -	10 0 0			
15 September	Sheriff's Court, Edinburgh.	Midlothian Gunpowder Company, Limited, Camilty Mill, West Calder, N.B. (Factory 143, Edinburgh.)	Do. -	1	Having excess of 182 lbs. of explosive in No. 17 (this being second offence).	Guilty -	30 0 0	1 0 0	—	
				2	Having No. 17 dirty (second offence) -	Do. -	5 0 0			
				3	Not maintaining mounds in accordance with statute.	Do. -	25 0 0			
					Total - -		145 0 0	24 19 3	—	

APPENDIX T (*b*).

PROSECUTIONS (Local Authority Cases).

Date of Hearing.	Place of Hearing.	Name of Offender.	Act under which Proceedings were taken.	Number of Information.	Nature of Offence.	Result of Hearing.	Amount of Penalty.	Amount of Costs.	Amount of Forfeiture or Penalty in lieu.	Remarks.
1893.							£ s. d.	£ s. d.	£ s. d.	
20 January -	Stanhope -	Robert Sisson - - (Registered premises No. 2,355.)	Explosives Act, 1875.	1	Selling explosive to a child under 13 years of age.	Convicted -	0 6 0	0 7 0	—	This prosecution arose out of Accident No. 2. (*See* Appendix W.)
Do. -	Do. -	Do. do. -	Do. -	2	Allowing his daughter to go to the safe, and not taking due precautions.	Do. -	—	0 7 0	—	
13 February -	Sheriff's Court, Glasgow.	Hugh Kennedy and Sons, Contractors, Markland Street, Partick; and Hugh Kennedy, Redclyffe, Partick Hill. (P.N.C. 346.)	Do. -	—	Keeping 25 lbs. gelignite in shed not authorised for keeping explosives, in Grovebank Place, Glasgow.	Do. -	2 10 0	—	—	Respondents pleaded guilty for their manager, Robert Lee.
17 February -	Sheffield -	William George Liversedge, Broad Street, Park, Sheffield. (Registered premises No. 655.)	Do. -	1	Having an excess of 100 lbs. of gunpowder on his registered premises.	Do. -	0 16 8	0 7 0	—	
Do. -	Do. -	Do. do. -	Do. -	2	Having more than 1 lb. of gunpowder not in closed bag or other receptacle on the same.	Do. -	0 1 2	0 7 0	—	
23 March -	Chippenham, Wilts.	James Bakewell Worrilow, Chippenham. (Registered premises No. 2,178).	Do. -	1	Making fit for use, damp gunpowder, by placing it on a stove to dry, in his registered premises.	Do. -	2 0 0	0 8 0	—	
Do.	Do. -	Do. do. -	Do. -	2	Having a fire in a room in which the filling of cartridges was being carried on on the same premises.	Do. -	0 1 0	0 6 0	—	
						Carried Forward -	5 14 10	2 2 0	—	

Prosecutions (Local Authority Cases)—*continued*

Date of Hearing.	Place of Hearing.	Name of Offender.	Act under which Proceedings were taken.	Number of Information.	Nature of Offence.	Result of Hearing.	Amount of Penalty.	Amount of Costs.	Amount of Forfeiture or Penalty in lieu.	Remarks.
							£ s. d.	£ s. d.	£ s. d.	
1893.					Brought Forward -	- - -	5 14 10	2 2 0		
23 March -	Chippenham, Wilts.	Frederick William Hampton, Chippenham, Wilts. (Registered premises, No. 2,178.)	Explosives Act, 1875.	—	Not taking precautions to prevent accident by fire or explosion when employed in filling cartridges on the same premises.	Convicted -	0 5 0	0 7 0	—	(*See also* Accident No. 18, Appendix W.)
7 April -	Ruabon - -	George Nicholson, Receiver, of Vauxhall Colliery Company, in liquidation. Ruabon. P.N.C. 343.	Do. -	—	Keeping compressed gunpowder cartridges, roburite and electric detonator fuzes, in unauthorized places.	Do. -	5 0 0	1 12 0	—	
8 April -	Folkestone -	Charles Edward Hillsdon, 14, Harbour Street, Folkestone. (Registered premises, No. 2,317.)	Do. -	—	Having an excess of 53 lbs. of gunpowder on his registered premises.	Do. -	1 6 6	0 10 0	—	
11 April -	Rochester, Kent	Messrs. Bridges and Forss, 65, Fenchurch Street, E.C. (Mag. No. 266, "Adrien.")	Do. -	1	Permitting the powder boat "Superb," whilst having more than 300 lbs. of explosives on board, to be moored to the magazine "Adrien," in Higham Bight, when not engaged in loading or unloading explosives.	Do. -	10 0 0	0 9 0	—	Byelaw 3 of the Thames Conservancy, made under the Explosives Act, 1875; and
Do. -	Do. -	Do. do. -	Do. -	2	Leaving the vessel there without the same being constantly attended by one person, its hatches being unlocked and the explosives exposed.	Do. -	10 0 0	1 17 6	—	Byelaw 28 of the Thames Conservancy, made under the Explosives Act, 1875.
Do. -	Do. -	Thomas Forss, 65, Fenchurch Street, E.C. (Mag. 266, "Adrien.")	Do. -	1	Removing the aforesaid vessel containing 12 cases detonators, one case socket sound signals and friction tubes, and one case fireworks and frictional lights from Hole Haven, the same having been seized in Higham Bight and removed by Thames Conservancy Inspector.	Do. -	15 0 0	1 12 0	—	
						Carried Forward -	47 6 4	8 9 6		

Prosecutions (Local Authority Cases)—*continued.*

Date of Hearing.	Place of Hearing.	Name of Offender.	Act under which Proceedings were taken.	Number of Information.	Nature of Offence.	Result of Hearing.	Amount of Penalty.	Amount of Costs.	Amount of Forfeiture or Penalty in lieu.	Remarks.
							£ s. d.	£ s. d.	£ s. d.	
1893.					Brought Forward -	- - -	47 6 4	8 9 6		
11 April -	Rochester, Kent	Thomas Forss, 65, Fenchurch Street, E.C. (Mag. 266, "Adrien.")	Thames Conservancy Act, 1864.	2	Assaulting the Conservancy officer who, in the execution of his duty, had seized and taken possession of the said vessel and explosives.	Convicted -	2 10 0	0 8 0	—	
28 April -	Llangollen -	Thomas Bushby, Trevor Hall Lime Works, Llangollen, Ruabon, (P.N.C. No. 342.)	Explosives Act, 1875.	—	Keeping guncotton and blasting powder in unauthorised places.	Do. -	3 0 0	0 19 0	—	
Do. -	Do. -	Messrs. Roberts and Maginnis, Garth Works, Llangollen. (P.N.C. 341.)	Do. -	—	Keeping blasting powder in an unauthorised place.	Do. -	1 0 0	0 13 0	—	
26 May -	Llansilin -	The Glyn-Ceiriog Granite Company. (P.N.C. 345.)	Do. -	—	Keeping explosives, viz., gunpowder, guncotton, bellite, gelignite, and detonators, in an unauthorised place.	Do. -	1 11 0	0 9 0	—	
30 May -	Llangollen -	The Glyn-Ceiriog Granite Company. (P.N.C. 344.)	Do. -	—	Keeping explosives, viz., blasting powder, guncotton, gelatine, and bellite, in an unauthorised place.	Do. -	5 0 0	0 7 6	—	
3 November -	Gravesend Police Court.	James Edwards. 3, Windmill Street, Gravesend.	Do. -	—	Manufacturing explosives, to wit, squibs, in an unauthorised place, viz., a photographer's shop.	Do. -	5 0 0	—	—	Or imprisonment for one month.
Do. -	Do. -	William Cooper, 14, Brewhouse Yard, Gravesend.	Do. -	—	Do. do. - -	Do. -	2 0 0	—	—	Or imprisonment for one month.
					Carried Forward -		67 7 4	11 6 0		

Prosecutions (Local Authority Cases)—*continued.*

Date of Hearing.	Place of Hearing.	Name of Offender.	Act under which Proceedings were taken.	Number of Information.	Nature of Offence.	Result of Hearing.	Amount of Penalty.	Amount of Costs.	Amount of Forfeiture or Penalty in lieu.	Remarks.
1893.					Brought Forward -	- - -	£ s. d. 67 7 4	£ s. d. 11 6 0	£ s. d.	
17 November	Police Court, Dale Street, Liverpool.	Messrs. Langstaff, Ehrenberg, and Pollak. (Irregular Importation.)	The Explosives Act, 1875.	—	Taking delivery of 10 packages of fireworks from the steam tender "Satellite" without first having obtained an importation license, such packages having been imported from Havre.	Convicted -	2 0 0	0 4 6	—	*It was announced by the Chairman of the bench at the conclusion of the hearing of these three cases that fines of 40s. and costs were imposed in each case, and the clerk to the magistrates entered the matter in his book accordingly, but some days afterwards the clerk to the magistrate informed the solicitor who prosecuted, that the Chairman had since informed him that the magistrates had dismissed the third information, though a conviction had been entered in the respective books of the magistrates' clerk and the fines collector, but in the magistrates' book two convictions only had been recorded.
Do. -	Do. - -	The Cunard Steamship Company, Limited.	Byelaw No. 6 of Board's Explosives Byelaws made under Explosives Act, 1875.	1	Making use of their tender "Satellite" for the conveyance of explosives within the jurisdiction of the Mersey Docks and Harbour Board, the same not being a duly licensed boat.	Do. -	2 0 0	0 4 6	—	
Do. -	Do. - -	Do. do. -	Byelaw No. 26 of Mersey Docks and Harbour Board Byelaws made under the Explosives Act, 1875.	2	Failing to send the necessary notice of the transhipment of 10 packages of fireworks from the S.S. "Landore" into the steam tender "Satellite" to the head constable and to the dock secretary.	Dismissed*	—	—	—	
					Total - -		71 7 4	11 15 0		

APPENDIX U.

Seizures of Explosives effected during the Year 1893.

Index No.	Owner or Occupier.		Date of Seizure.	Where seized.		Officer by whom Seizure was made.	Explosive, &c. seized.	Home Office Registry No.	How disposed of.
	Name.	Address.		County.	Place.				
1	Fortis Powder and Explosives Co., Limited.	35, New Broad Street, E.C.	1893. 26 Jan.	York	Factory No. 134, Denaby.	Colonel Ford	200 lbs. gunpowder 50 lbs. compressed cartridges.	—	Released, 10 February.
2	W. G. Liversedge	13, Broad Street, Sheffield	30 Jan.	Do.	Registered Premises, No. 655.	Do.	107 lbs. gunpowder	—	Prosecuted, convicted, and fined. *See* Appendix T (*b*).
3	C. E. Hillsdon	14, Harbour Street, Folkestone.	4 Apr.	Kent	Registered Premises, No. 2,317.	Do.	52 lbs. gunpowder	—	Do. do.
4	T. Hengst	20, Burwash Road, Plumstead.	28 Apr.	Do.	20, Burwash Road, Plumstead.	Colonel Majendie	4 lbs. black powder ½ lb. Schultze powder.	—	Destroyed. *See also* Appendix W., Accident No. 29.
5	J. R. Watson	35, Queen Victoria Street, E.C.	24 Mar.	Cornwall	Penryn	Do.	200 lbs. dyed Cooppal's powder	—	Imported under License 410*a*. Released for return to port of origin.
6	Midlothian Gunpowder Co., Limited	West Calder, Edinburgh	27 July	Edinburgh	Factory No. 143	Do.	175 lbs. cartridges	—	Prosecuted, convicted, and fined. *See* Appendix T (*a*).
7	Darbishires, Limited	Quarry Owners, Penmaenmawr.	31 July	Carnarvon	Magazine No. 363.	Captain Thomson, R.A.	2,000 detonators	60,316A	Released, 8th August.
8	Thompson & Co.	Iron Merchants, Wigan	14 Nov.	Lancashire	Magazine No. 282.	Do.	300 detonators	—	Released, 18th November.

Seizures without Warrant.

2nd March.—Seizure by Local Officer under Explosives Act, at Somerton, Somerset, of 4½ lbs. gunpowder, on unregistered premises which are used for the village post office. The explosive was kept in a loose way, and was found dangerously near the mails. The occupier, Honor Bowden, was prosecuted, and fined 8*s*., including costs.

APPENDIX V.

Home Office, Whitehall, S.W.,
11th October 1893.

In forwarding you a copy of a report of the results of an inquiry into an Accident (No. 63, 1893) which occurred on Saturday the 19th August last at Messrs. C. T. Brock and Company's Firework Factory at South Norwood, I desire to call your attention to the fact that this accident appears to emphasise the risk which has for some time past been recognised as attaching to the use of firework compositions containing an admixture of sulphur and chlorate of potash, and I would especially refer you to the opinion of the Chemical Adviser of this Department, as set forth in the enclosed report. Having regard to this opinion, and to the additional evidence which the accident in question affords of the soundness of the views so strongly expressed by Dr. Dupré, it appears to me that if practicable it would be extremely desirable that compositions containing these ingredients should be absolutely prohibited.

Before, however, submitting any definite proposition on the subject to the Secretary of State, I am anxious to obtain as much information as possible as to the practice and requirements of the trade in regard to the use of such a composition. I should, therefore, feel obliged if you would favour me with your views upon the subject, and especially whether, in your judgment, the use of compositions of so dangerous a character can be altogether dispensed with. Any observations with which you will be good enough to favour me will receive careful consideration, and if you desire will be treated as confidential.

I have, &c.
(Signed) V. D. MAJENDIE, Colonel,
H.M. Chief Inspector of Explosives.

To all Firework Manufacturers.

APPENDIX W.

ACCIDENTS by FIRE or EXPLOSION which have come under the notice of the Home Office from 1st January to 31st December 1893.

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons		Home Office Registry No.
					Killed.	Injured.	
1	1893. 3 Jan.	Dynamite -	On Manchester, Sheffield, and Lincolnshire Railway, between Beighton and Killamarsh.	A railway labourer was engaged in ramming a charge preparatory to blasting some rock, when the charge exploded, causing injuries to him from which he died. A wooden rammer had been provided, the deceased, however, used an iron scraper instead.	1	—	x. 40,165
2	6 Jan.	Blasting gelatine or gelatine dynamite.	Stanhope, Durham -	The deceased, aged 17, a quarryman, was carrying in his hand a parcel of "gelatine" from Stanhope along the road to the Ashes Limestone Quarry when an explosion took place, and he received severe injuries from which he died the next day. Immediately before the explosion he was observed to be scraping out his pipe with his knife, and there can be no doubt that some fire in it caused the explosion. Proceedings were instituted against the vendor of the explosive (R. Sisson) for selling explosive to the deceased's sister, a child under 13 years of age, and a penalty was inflicted. (*See* Appendix T (*b*).)	1	—	

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons Killed.	No. of Persons Injured.	Home Office Registry No.
*3	1893. 9 Jan.	Tonite or cotton powder.	Manchester Ship Canal Works, Rixton.	In order to deepen the River Mersey, near a wharf, seven holes were bored in the bed through tubes let down from a pontoon. Three 14 oz. cartridges of tonite, enclosed in zinc cylinders, were then placed in each hole, the first two being dropped and the third lowered through the tube by the fuze and tamped with sand. The fuzes having been lighted the tubes were raised into the pontoon, which was then moved away. Six of the charges exploded in the holes, but the seventh was brought up into the pontoon and exploded in the tube, killing one man and injuring three others badly. It was clear that in that case the cartridges did not drop into the hole (which was of smaller diameter than the tube) and were inadvertently tamped in the tube instead of in the hole. One of us attended the inquest, at which a verdict of "accidental death" was returned. For the future single cylinders containing the whole charge will be employed.	1	3	B 9753 D
4	10 Jan.	Gunpowder	Factory No. 26, Glyn-Neath, Glamorgan. (Messrs. Curtis's and Harvey.)	No. 7 mill exploded on a green charge on the machinery being started. No person was injured, and the damage was very slight. The cause was not ascertained.	—	—	
5	7 Jan.	Gunpowder	Copt Hill, Stanhope, co. Durham.	A lead miner was engaged (as he stated) in emptying a quantity of gunpowder out of a tin canister into a bag containing about 7 lbs., for the purpose of taking it into the mine, when an explosion occurred, doing considerable damage to the house, and injuring the miner, his wife, and child. The miner stated he could not account for the explosion, but as he admitted that he was near the fire at the time, it is reasonable to suppose that a spark therefrom caused the powder to ignite.	—	3	
6	17 Jan.	Gunpowder	Premises of Mr. Thomas Lyttle. (Maghera, Londonderry.) (R.P. No. 2,325.)	The gunpowder was kept in a strong sheet-iron box or safe, 30 inches high and about 18 inches in width and depth, and was placed at the end of a store about 43 yards from a public street. This store is reached by passing through Lyttle's shop, across a yard, up a ladder, into a loft, then through two other stores 17½ × 19 feet long respectively. It was believed that Lyttle's servants in taking powder from the safe let some drop from time to time on the floor, and that the powder thus spilled became ignited either by friction or by the lighting of a match. At the time of the explosion there were two persons in the store where the safe was situated; both were a good deal burnt.	—	2	

* Compare with Accident No. 102.

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons		Home Office Registry No.
					Killed.	Injured.	
	1893.						
7	19 Jan.	Detonator -	Factory No. 18, West quarter, Stirling. (Nobel's Explosives Co., Limited.)	A detonator exploded while being extracted from a "jig." No one was injured. It appears that it is the custom to press 100 detonators at a time. These detonators are contained in a brass plate called a jig. After pressing, the jig is removed from the machine and inverted over a box of sawdust. The tubes consequently fall out and are removed. It occasionally happens that a detonator will not fall out, and then the jig is put into an iron box and the tube gripped with a pair of tongs and pulled out, and it was in doing this that the explosion occurred.	—	—	
8	10 Jan.	—	Sun Wharf, Deptford. (Messrs. D. McCall & Co.'s premises.)	Messrs. McCall carry on the business of dealers in old iron, copper, and brass. In the course of their business they purchased large quantities of metal, some of which they obtained from a Mr. Robinson. Among the metal so purchased was what was described as a copper tube about 6 inches long and from $1\frac{1}{2}$ to 2 inches in diameter, the copper being about $\frac{1}{10}$th of an inch thick. One end was open, the other closed with copper. It appeared to be empty, but about two-thirds down the tube Mr. McCall noticed some solder, and in order to remove this he placed it in a small heating stove, and not long afterwards an explosion occurred and three persons who were in the room at the same time received injuries which in the case of two of them were of a serious character. A subsequent examination of the heap of old metal at Mr. Robinson's premises resulted in the discovery of a large number of shells for the 6-pr. quick-firing gun. These shells had been disposed of as old metal by the Maxim-Nordenfelt Company, and were found to contain explosive. The Company were prosecuted and fined 10*l.* and 5*l.* 5*s.* costs (exclusive of court costs). (*See* Appendix T (*a*).)	—	3	
9	19 Jan.	Gelatine dynamite.	Halkyn Mine, Holywell, North Wales.	The deceased returning too soon to his working place under the impression that the two shots (which he and a comrade had fired) had gone off, received injuries to which he succumbed. His comrade was slightly injured.	1	1	
10	— Feb.	Detonator -	Dumfries - -	Some boys found several detonators in a place where a number of them were being unlawfully kept, and they placed one on a rail in a railway yard hard by and struck it with a stone, with the result that one boy received injury to two of his fingers.	—	1	

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons. Killed.	No. of Persons. Injured.	Home Office Registry No.
	1893.						
11	23 Feb.	Dynamite -	Machine house of Mr. Lewis Thomas, Wern Colliery, Pontypridd.	A collier put some cartridge on a shovel on the fire in the machine-house to thaw them, when they (naturally) exploded, injuring him and another man slightly.	—	2	
12	18 Feb.	Blasting gelatine.	Fallahill Quarry, Whitburn, Linlithgow.	William Duncan, a miner, aged 42, had bored and charged two holes, one of which was bored to 22 inches, the other to 12 inches, in each was inserted the charge, together with a "Strum" fuze. The fuze was 24 inches long in the former case, and 15 inches long in the latter. He lit the shortest fuze, as he wanted it to explode first, to give the other shot a better chance of doing its work. The shot did not go off, and after an interval of 15 minutes, thinking it had missed, he returned, and ignited the other fuze and retired. Shortly afterwards a shot exploded, and he waited until the smoke cleared, and on passing his working place, the second shot went off, and he was struck in the right side of the face and also in the right arm. It is believed that the fuze smouldered for at least 20 minutes before the spark reached the detonator. Duncan was acting in contravention of the rules in going near the shot before the time laid down in the special rules (thirty minutes) had elapsed.	—	1	
13	1 Mar.	Detonator -	Minera Mine, Wrexham.	A miner fired a detonator whilst fastening it to a fuze. He was injured in the face by the explosion.	—	1	
14	9 Mar.	Gunpowder	Factory No. 143, Edinburgh. (The Midlothian Gunpowder Company, Limited.)	An explosion occurred in one of the incorporating mills, extending to the adjoining mill, at the moment when two of the workmen were approaching the mills with a view to stopping the machinery preparatory to uncharging. The mills were on 80 lb. charges of blasting powder. Although the actual cause could not be positively ascertained, it is reasonable to believe that the explosion was due to the mills having been "over-run"; *i.e.*, the charge is believed, through carelessness on the part of the millmen, to have been run for about 50 minutes longer than its proper time, and would thus be unduly dry and sensitive.	—	2	
15	15 Mar.	Gunpowder	Brynia Stone Quarry, Bangor, North Wales.	A labourer was employed in connexion with the building of the new training college at Bangor, when a stone, thrown by blasting in a stone quarry 85 yards away, struck him on the head and caused his death.	1	—	
16	13 Mar.	Mixture containing Potassium Chlorate instead of Saltpetre.	Factory No. 76, Surrey. (Messrs. C. T. Brock & Co.)	The accident was due to the inadvertent use of some chlorate of potash instead of saltpetre (under which designation it had incorrectly and improperly been consigned to Messrs. Brock) in a composition which was being charged into drain-testers. (*Inquiry and Special Report, No. CIII.*)	1	1	

Index No	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons Killed.	No. of Persons Injured.	Home Office Registry No.
17	1893. — Feb.	Detonator -	House of Thomas Dinwiddie, Irving Street, Dumfries.	A boy was picking a detonator with a needle. The resulting explosion injured a thumb and two fingers.	—	1	
18	10 Mar.	Gunpowder	Mr. J. B. Warrilow's premises, Chippenham, Wilts. (Registered premises, No. 2,178.)	It appears that when filling some cartridges a lad (named Hampton) placed a can containing about one or two pounds of powder on a stove, to dry, as the powder had become clotty, and would not go into the holes in the filling machine. The stove was blown to pieces, and further damage was done. The explosion, fortunately, was unattended with loss of life, and no personal injury was sustained. Proceedings were taken against Warrilow and Hampton, the result of which will be found in Appendix T (*b*).	—	—	X 41106
19	3 Mar.	Gunpowder	Popplewell Colliery, Scholes, Yorkshire.	Two miners were preparing to fire a shot in the pit, and whilst they were ramming the same with a wooden rammer, the charge exploded, injuring both of them. One of them ultimately succumbed to his injuries. The coroner's jury returned a verdict of accidental death.	1	1	
20	24 Mar.	Gunpowder	Factory No. 15, Derby. (The Chilworth Gunpowder Company, Limited.)	The accident was caused through the incautious use of a brass hammer by the engineer in testing the iron securing bolts of the centre upright of the mill. The charge had been lifted, the mill cleaned down, and the bed watered, preparatory to putting on a new green charge. The engineer was making his daily round to examine the machinery, and on tapping one of the bolts he thought the sound was dull (indicating fracture), and tapped it again with a little greater force. An explosion of the clinker ensued, and he was burnt about the head, arms and thighs. The millman, who was passing the mill at the time with the worked charges in a properly covered tramcar, was slightly burnt about the hands, but the explosion was not communicated to the charges. Very little damage was done to the mill, beyond the blowing out of the light front and roof of the building.	—	2	
21	23 Mar.	Blasting gelatine.	Main Sewage Works, Abbey Road, Kirkstall, Leeds.	Deceased (with three other men) was engaged in certain blasting operations, connected with the cutting of a sewer, and he was at the bottom, in the act of putting in a charge, when it exploded, killing him on the spot and injuring another man. The accident was doubtless due to the excessive force used in ramming the charge. It is not known whether or not he was using the wooden rammer provided. The coroner's jury returned a verdict of accidental death.	1	1	X 41301

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons Killed.	No. of Persons Injured.	Home Office Registry No.
	1893.						
22	28 Mar.	Gunpowder	Great Orme's Head Quarries, Llandudno.	Two men were engaged in blasting with gunpowder, with a view to improving a roadway, and were ramming a charge when it exploded, severely injuring both men.	—	2	
23	30 Mar.	Gelatine dynamite.	Whistlefield, Dumbartonshire.	Blasting had been carried on for some days on a rock cutting of the West Highland Railway, and it is believed that the injured man struck with his pick a cartridge, or portion of a cartridge, which had remained unexploded from a former charge, and the existence of which was not suspected.	—	1	X 41417
24	5 Apr.	Detonator -	Factory No. 18, Westquarter, Stirling. (Nobel's Explosives Company, Limited.)	A detonator exploded while being pressed. Punches bent, jig and extracting plate destroyed. Several frames of glass broken. No one was injured. Cause of accident not ascertained.	—	—	
25	6 Apr.	Gunpowder	The Oakeley Quarries, Blaenau-Festiniog, North Wales.	A shot went off whilst Robert Evans was tamping a hole; the tip of the tamper was of brass.	—	1	
26	14 Apr.	Gelatine dynamite.	Llanfair Mine, Llanfairtalhaiarn, near Abergele, North Wales.	A miner and his partner had bored and charged two holes in an "end." No. 1 was arranged to go off before No. 2; both candle-ends or snuffs had been lighted. He saw No. 1 fuze spit and the snuff of No. 2 fall down. He retired to a safe place, heard No. 1 go off, and returned in order to re-light No. 2. Just as he got to the end No. 2 exploded, inflicting fatal injuries on him. He had concluded that the snuff had fallen off before it had ignited the fuze, but he was mistaken.	1	—	X 41670
27	18 Apr.	Detonator -	Halkyn Mine, Holywell, North Wales.	A miner fired a detonator whilst putting it on to a fuze. The explosion injured his eyes severely.	—	1	
28	18 Apr.	Dynamite -	Penrhyn Slate Quarries, Carnarvon.	A man was killed in a level during the operation of blasting.	1	—	X 41717
29	23 Apr.	Hengst's Powder.	House of Mr. Hengst, 20, Burwash Road, Plumstead.	Mr. Hengst was engaged in preparing some new bronze alloy, and he poured some of it out of the crucible, whence it ran down into or on to a tin containing about one or two pounds of smokeless powder which had accumulated from some experiments which he had been carrying on. He claimed to have made the powder in virtue of section 4 of the Act, but that would not authorise the *keeping* of explosives of an unauthorised description.*	—	2	
30	29 Apr.	Amorces -	Factory No. 145, Surrey. (Mr. H. J. Cadwell.)	Three hundred amorces, which were being cut in a machine, took fire, and the fire was communicated to 300 already cut in boxes below the machine. No one was injured, and no damage was done to the machine or the shed.	—	—	

* All the remaining explosive found in Mr. Hengst's room was ultimately destroyed.

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons		Home Office Registry No.
					Killed.	Injured.	
	1893.						
31	26 Apr.	Gunpowder	Factory No. 49, Hounslow, Middlesex. (Messrs. Curtis's and Harvey.)	Nos. 10 and 11 exploded on a treble strong 60 lb. charge after working for five hours. The charge had been liquored five minutes previous to the explosion. No one was injured, and the damage done was slight. Cause of accident not ascertained.	—	—	
32	2 May	Nitro-glycerine.	Factory No. 3, Ayr. (Nobel's Explosives Co., Limited.)	One of the chemists was examining a small sample of nitro-glycerine in the laboratory of the factory when it exploded, and his face and hands were cut with the glass of the bottle in which it was contained. The damage to the laboratory was trifling, consisting chiefly of broken windows.	—	1	
33	27 Apr.	Dynamite -	Tunnel of the Glasgow Corporation Waterworks, Strathblane.	Five holes had been charged with dynamite and the fuzes lighted. The four men engaged in the work were walking along the tunnel to a safe distance, when one of them was struck in the heel by a piece of stone from the explosion; his boot was torn away and his foot was shattered.	—	1	X 41997
34	5 May	Amorces -	Factory No. 145, Surrey. (Mr. H. J. Cadwell.)	The inexplosive waste from the amorce cutting machine (*i.e.*, the paper sheets from which the amorces had been punched) caught fire, evidently from a light from one of the amorces. The machine man did not notice it until it was well alight. The portion of the building where the waste caught fire was damaged by fire, but no one was injured, and no further damage done.	—	—	
35	1 May	Unknown -	Bridge End huts, Thirlmere.	The explosion took place in the kitchen range, by which a child, nine years of age, was fatally injured, and the child's mother was much injured. As to the cause of the accident, no definite conclusions can be come to on the available evidence. It at first appeared probable that it was due to the presence of some explosive in the coal, but it was elicited at the evidence that the explosion did not occur in the fuel at all, but either in or on the oven, or in the flue. But what the explosive was, and how it came there, the evidence did not show.	1	1	
36	5 May	Gelatine dynamite.	Aberllefenny Slate Quarries, Machynlleth, North Wales.	A miner was widening a crossing from main level, to prepare for a roof; he had fired the fuze, but had not gone far enough in the level to escape the effects of the blast. He was severely injured by some stones rebounding.	—	1	
37	27 April	Gunpowder	South Creighall, East Kilbride, Lanarkshire.	It appears that it was the habit of the workmen employed in cutting a drain for water on the farm, to bring their tea in flasks, which the carter used to warm on the stove. One of the men happened to have two flasks, one of which contained gunpowder, and this latter was, inadvertently, put on the kitchen fire to warm.	—	4	X 40243

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons Killed.	No. of Persons Injured.	Home Office Registry No.
	1893.		South Creighall, East Kilbride—*cont.*	The explosion which followed injured those in the kitchen at the time, viz.: the woman who occupied the house, together with her two children, and the carter who was warming the tea.			
38	14 April	Gunpowder	12, Simpson Street, Glasgow.	A boy (aged 11) was filling a small toy cannon, in the closet, with powder. It being somewhat dark, he lit a match to see how to fill it—a spark fell amongst the powder, and the ensuing explosion burnt him severely, and almost wrecked the closet. He had been unable to buy the powder (about 1 lb.) himself, but prevailed on a man whom he met outside the shop to get it for him.	—	1	X 42042
39	6 May	Dynamite -	Underground Railway Works, Great Western Road, Glasgow.	Some blasting had been carried out with dynamite, and the day shift had just started clearing away the *débris* from the face in which several charges had been previously exploded by the night shift, when (doubtless through striking into some unexploded portion of a charge) an explosion occurred through which three men sustained injury.	—	3	
40	11 May	Priming composition (No. 1, Abel's).	Factory No. 18, Stirling. (Nobel's Explosives Co., Limited.)	The ingredients for making the composition are mixed together with an ivory spatula, the work being done on a sheet of paper lying on the table. It would appear that a drop of shellac varnish had fallen on the table and become hard. The mixing paper was placed over this without its being noticed, and the spatula must have ignited the composition by friction when passing over it. A special mixing table will now be used. About 5 ounces of composition were destroyed. No one was injured, and the damage consisted in the table being scorched.	—	—	
41	17 May	Detonator -	Factory No. 18, Stirling. (Nobel's Explosives Co., Limited.)	A detonator exploded while it was being pressed. No one was injured. The punch had the point broken off, whilst the anvil was defaced.	—	—	
42	26 May	Smokeless powder.	Factory No. 135, Hertfordshire. (The Smokeless Powder Co., Limited.)	A spark from boiler house chimney entering the window of drying house, No. 15, set fire to the explosive and inflicted extensive burns on two men resulting in their death. (*Inquiry and Special Report CIV.*)	2	—	
43	1 June	Ammunition (Bulletted breech caps). (Safety cartridges.)	Factory No. 46, Witton, Stafford. (Messrs. G. Kynoch and Co.)	While a workwoman was engaged in choking a small safety cartridge the cap exploded, cutting her hand slightly. The cap in question was an ordinary rim-fire bulleted breech cap.	—	1	

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons		Home Office Registry No.
					Killed.	Injured.	
	1893.						
44	3 June	Fire - -	Factory No. 24, Cornwall. (The East Cornwall Gunpowder Co., Limited.)	A fire occurred in the store for unground charcoal amongst some charcoal that had only recently come into store—due, it is supposed, to spontaneous ignition and to the fact that it had been sent on from the chemical works before it had been properly cooled. As it was a very hot and bright sunny day when it came in, any warmth in the bags would escape observation in handling. No damage of any importance was done.	—	—	
45	3 June	Fire - -	Premises of Messrs. Doig and Sons, 9, High Street, Dundee. (Registered premises, No. 2,333.)	An assistant had taken 1½ ounces of soluble nitro-cotton from a bottle in the shop for the purpose of dissolving it in ether and alcohol in order to make collodion, when an explosion occurred, and he, together with another man in the shop, was cut by fragments of glass from broken bottles. Gas was burning in the shop at the time, and it is supposed that a mixture of the vapour of the ether and air had been set on fire either by the gas or by the ignition of the nitro-cotton from friction, and exploded. The explosives stored on the premises were not affected by the accident.	—	2	X 42584
46	15 June	Fireworks (rocket).	Factory No. 73, Surrey. (Messrs. Jas. Pain and Sons.)	A workman was engaged in charging a 4 oz. rocket, and on striking the first blow to the wooden solid tool to set down the heading an explosion occurred, due, it is supposed, to the spindle not being entirely covered with composition. He at once carried it out of the shed, and it burnt away slowly outside. The bowl of composition from which he had been filling was, however, set on fire, but, except that the interior of the shed was slightly burnt and the windows cracked, no damage was done.	—	—	
47	14 June	Amorces -	Factory No. 145, Surrey. (Mr. H. J. Cadwell.)	A quantity of sheets of uncovered amorces caught fire (in Building A[1]). They burnt away without causing any damage. The cause of the accident is attributed to rough handling of the sheets of amorces.	—	—	
48	14 June	Fire -	Factory No. 114, Warwick. (The Birmingham Ammunition Company, Limited.)	A fire broke out in one of the sheds (outside the danger area) in which the operation of greasing bullets was carried on. This shed, together with the closets was burnt to the ground, and the mill stores were gutted. The fire, however, was got under control, just as it had taken hold of the drying house and shed No. 32 (licensed for storing safety cartridges), to which very little damage was done, mostly by water.	—	—	

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons		Home Office Registry No.
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	1893.						
49	17 June	Dynamite and detonator.	Severn riverside, near Llanidloes, Montgomery, North Wales.	Three young men were walking along the side of the River Severn, when one of them fixed a detonator in a charge of dynamite and lit the fuze attached to it; and whilst he was preparing a second charge of dynamite the first one exploded, with the result that his right hand was blown to pieces, and his thigh much mutilated. It is supposed that the men were poaching.	—	1	
50	21 June	Gunpowder	Stone Quarry, Brynford Mountain, Holywell.	Two men were boring out the tamping of a charge of gunpowder, which had missed fire four hours before. The explosion which followed injured them, but not badly. The newspapers contained an incorrect and exaggerated account of the accident.	—	2	
51	21 June	Blasting gelatine.	Blackrigg Colliery -	A collier had prepared two shots (a "brushing shot" and a "plug") and after lighting them he retired. Hearing only *one* explosion, he returned to light the "plug," which he erroneously thought had missed fire, but which had actually fired. The "brushing shot" exploded as he approached it, and he was injured by the débris. The fact that he returned so soon, without waiting for the 30 minutes allowed by the rules to elapse, was a contravention of the rules, and to this circumstance the accident was due.	—	1	X 42915
52	13 May	Fire -	Factory No. 111. Carmarthen, (South Wales Explosives Company, Limited.)	On the evening of Saturday, May 13th, a fire broke out which destroyed the nitrating house, tunnel, separating houses, and filtering and mixing house, which houses, however, contained no explosive at the time; indeed the factory was (and for years had been) practically in disuse, although one of the magazines had, since November 1892, contained a little explosive to keep the license alive. The cause of the fire was not ascertained, although in the dry state of the grass it may have been caused by a passer-by dropping a pipe-light, it is believed to have been more probably the result of drunken frolic or deliberate malice.	—	—	
53	6 July	Gunpowder	Appledore, Devon -	Three small cannon were being used for firing salutes in connexion with the festivities and rejoicings in celebration of the Royal Wedding. Two of them had been obtained from a yacht in the harbour, and the third from a ship builder. The third one burst whilst being fired in the afternoon, killing one man instantly and slightly injuring another man. It was stated at the inquest that it had been fired at least 25 times previously during the day. The coroner's jury brought in a verdict of accidental death.	1	1	X 43040

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54	1893. 7 July	Ammonite -	Hatherton Limestone Mine, Walsall.	A man was charging a "pop" hole, when, owing to the rough impact upon the detonator, it went off. He had only just commenced to charge it; the explosion, consequently was slight. The man's arms were slightly burned. These "pop" holes are drilled into blocks of the limestone (which are too large to be lifted) so that they may be broken up by the shot. In this instance the detonator was only thinly covered by the first layer of tamping.	—	1	X 43046
55	11 July	Gunpowder	West Highland Railway, in course of construction, Killin, Perth.	The deceased had lighted the fuze of three shots and retired to a safe distance. Two only exploded, and after waiting about eight minutes he returned to ascertain why the third had failed to go off. On his arrival at the place it exploded, and he was killed instantly.	1	—	X 43159
56	20 July	Fire -	Factory No. 49, Hounslow, Middlesex. (Messrs. Curtis's and Harvey.)	The fire was caused by the spontaneous ignition of a cask of vegetable lampblack in a lean-to adjoining the caustic warehouse. No one was injured, and very little damage was done, the fire having been easily extinguished.	—	—	
57	27 July	Gunpowder	Factory No. 1, Yorkshire. (Messrs. Shortridge and Wright.)*	The explosion occurred in No. 1 mill, which had been running on a charge of sporting powder for about five hours, shortly after the charge had been liquored. The drenching apparatus acted in the adjoining mill. No one was injured.	—	—	
58	3 Aug.	Gunpowder	Factory No. 13, Westmoreland. (Messrs. W. H. Wakefield & Co.)	An explosion took place in No. 1 mill just as it had been started and the explosion was communicated to Nos. 2 and 3.	—	—	
59	8 Aug.	Guncotton -	Factory No. 7, Kent. (The Cotton Powder Co., Limited.)	A workman was loosening a charge of guncotton in the centrifugal acid wringer with a pricker when the charge ignited. He was slightly burnt about the face.	—	1	
60	10 Aug.	Safety fuze	Factory No. 126, Cornwall. (Mr. Edward Tangye.)	The greater part of the factory for safety fuze was burnt down, but without causing personal injury. The fire occurred in the night, and is attributed to the furnace used for heating the varnish, the damper having been left open, the fire got up and caused the tar to boil over and become ignited, setting fire to the wooden portion of building "D." The factory magazine for gunpowder, and a building used for filling the metal tubes with gunpowder, being isolated buildings escaped destruction. About 2,000 coils of metallic fuze not covered with thread, &c., and about 4,000 coils of fuze in a more advanced stage of manufacture were consumed, but without any explosion. The only explosion resulting from the fire was one of about 5 lbs. of gunpowder in one of the small expense magazines.	—	—	

* Now in the occupancy of Messrs. Kynoch and Company.

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	1893.						
*61	8 Aug.	Guncotton -	Factory No. 7, Kent. (Cotton Powder Co., Limited.)	Guncotton in acid centrifugal fired while being removed by hand, slightly burning a workman. No instrument was being employed. The accident is attributed to the heat of the weather, but was no doubt caused by contact of the acid guncotton with perspiration from the man's face or hands.	—	1	
62	17 Aug.	Gelignite -	Pwlldu Quarry, near Blaenavon, Monmouthshire.	The deceased was engaged in charging a hole with gelignite, and was using an iron rammer for the purpose. He had introduced the greater part of the charge, and when ramming home the eighth cartridge it exploded. The jury returned a verdict that death was due to misadventure caused by an explosion of gelignite whilst charging a shot hole with an iron rammer. The company subsequently stated that the iron rammers now in use would be immediately withdrawn and replaced by others either of wood or of copper.	1	—	
63	19 Aug.	Firework -	Factory No. 76, Surrey. (Messrs. C. T. Brock & Co.)	The deceased was at work in drying house No. 30, and was engaged at the time of the accident in emptying some crimson stars from one canvas bottomed tray into another similar one, when the explosion occurred, inflicting severe burns upon him to which he afterwards succumbed. The accident was probably due to the spontaneous combustion of coloured stars which was accelerated by the long sustained and exceptional heat of the weather. The building contained about 300 lbs. of composition at the time, and had the roof blown off and the wood lining damaged. (*Inquiry and Special Report, No. CV.*).	1	—	
64	23 Aug.	Gunpowder	Longhoughton Quarry	A man was killed during blasting operations by a stone falling upon him.	1	—	
65	6 Apr.	Detonator -	West Bromwich, Staffordshire.	Several children were at play and one of them found a detonator, placed it on a brick and struck it with a hammer; the explosion injured two of them slightly.	—	2	
66	24 June	Detonator -	West Bromwich, Staffordshire.	A lad found a detonator and began to prick the detonating composition with a needle; the resulting explosion blew off the fingers of his left hand and injured his brother slightly in the face.	—	2	
67	26 Aug.	Unknown -	184, Wyndford Street, Glasgow.	The explosion took place in a court behind a four-storey tenement, shattering the glass in the back windows of this and the adjoining house, and making a hole about 6 inches in diameter by 4 inches in depth in the asphalte pavement.	—	—	

* For cases of ignition in acid centrifugals, and observations on the same, *see* Annual Reports, for 1886, pp. 32, 33, 53; for 1887, p. 33; for 1888, p. 36; and for 1890, p. 33.

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons		Home Office Registry No.
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	1893.						
68	3 Sept.	Gunpowder	40, Plymouth Street, Merthyr Tydil.	A man named Thomas Williams, 53, lodged in the house of a miner, who, it appears, had some 3¼ lbs. of gunpowder in an open box in his bedroom. As Williams' candle was low down in the socket of the candlestick it is stated that he proceeded to his landlord's room with a view of obtaining some means of raising it. The candle dropped into the box and fired the powder, inflicting fatal injuries on Williams and doing considerable damage to the building.	1	—	
69	5 Sept.	Nitro-glycerine.	Factory No. 148, Cornwall. (British and Colonial Explosives Co., Limited.)	The explosion occurred about 7 p.m. in the bottom of the nitrating vat in "A" house. The vat had been used that morning for one nitration, and the accident was caused by the accumulation of scale which retained a proportion of acids, with nitro-glycerine. Decomposition is believed to have set in. It was estimated that not more than one ounce of nitro-glycerine was present at the time. No one was injured, and the damage consisted in the bottom edge of the vat having a hole made in it about a foot in length. One of the standards of the outside coils was severely bent, the wooden laggings of the casing of the vat displaced, the cover of the vat lifted and bent, while the acid inlet and earthenware tap, the glass in the vat cover and four or five windows were broken. The House itself was uninjured, and the charge of glycerine for the following days' work intact in the tank. The effects were such as might have been caused by about one ounce of nitro-glycerine. The explosion was undoubtedly due to the retention of acid and nitro-glycerine by scale at the bottom of the vat.	—	—	
70	8 Sept.	Guncotton -	Factory No. 9, Suffolk. (The New Explosives Co., Limited.)	The foreman engineer and a labourer had cleaned out three of the water centrifugal machines in Building H., previous to repairing; they placed the cleanings (about one pound of rusty guncotton and rubbish) in a box, and took them to a waste piece of land in order to burn them; but not wishing to burn too much at a time, they took a portion out of the box and set light to it, when a spark must have fallen into the box and ignited the remainder of the guncotton, as it immediately flared up, slightly burning the two men engaged about the face and hands.	—	2	
*71	5 Sept.	Detonator -	"Half Moon Inn," Easington.	Some men were in the bar of the "Half Moon" publichouse, and one of them (a quarryman) lit a piece of fuze, to which a detonator was attached, and threw it on the floor; the explosion slightly injured one of them. The piece of fuze and the detonator were supplied to the quarryman for	—	1	

* *See also* under head of "Outrages" a malicious explosion of very much the same character, which was caused at the "Tipton Tavern," Great Bridge, Staffordshire.

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	1893.		"Half Moon Inn," Easington—*cont.*	the purpose of blasting, and should have been handed back to the foreman when not used. The man has since been dismissed from his employment.			
72	2 Sept.	Smokeless Powder.	Factory No. 47, Kent. (The Maxim-Nordenfelt Guns and Ammunition Co., Limited.)	A small quantity of smokeless powder primers, weighing about four ounces had been placed in a small tin box, and a tinsmith was instructed to put a drop of soft solder so as to prevent the box being opened without detection. The man misunderstood the instructions, and began to solder the lid all round the side of the box; the primers took fire, but as the box was still partly open, did not cause any explosion, and simply a flame shot upwards, burning the man on the face and arm.	--	1	
73	9 Aug.	Firework (Socket Sound Signal).	Ashcroft, Brown's Road, Walthamstow.	It appears that some experiments were being made with a socket sound signal, which was supposed to have been old or of defective character. It ascended to a height of about 30 feet only, and on falling to the ground exploded with a loud report. No one was injured, and no damage was done beyond the breaking of a few panes of glass.	—	—	
74	12 Sept.	Gunpowder	Factory No. 38, Kent. (Messrs. John Hall and Sons.)	Two incorporating mills (marked 100 on the plan) exploded after running 2¼ hours on a 60 lb. charge. The charge had been liquored when put on, and again about three-quarters of an hour previous to the accident. No one was injured, and the damage was trifling. The cause of the accident was not ascertained.	—	—	
75	13 Sept.	Ammunition Safety Cartridge.	Kidderminster - R.P. 2,356.	A cartridge exploded while the powder wad was being pressed in, in an "Erskine" filling machine. One man was slightly injured. The accident is attributed to a shot having lodged in a groove in the bottom board under the cap of the cartridge.	—	1	
76	6 Sept.	Gelatine dynamite.	Dalbeath Colliery. (The Fife Coal Co., Limited.)	A night fireman had his left eye destroyed, and the right eye slightly scorched by a shot exploding when he was within 10 feet of it. It was stated that he did not hear the warning cry of "Fire." But, on the other hand, sufficient precautions do not appear to have been taken to prevent any one approaching the shot.	—	1	X 44067
77	16 Sept.	Fog-signal -	Factory No. 65, Kent (The Henry Rifled Barrel, Engineering, and Small Arms Co., Limited.)	A fog-signal exploded in the press in No. 19 shed. No damage was done.	—	—	

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	1893.						
78	19 Sept.	Firework -	Factory No. 73, Surrey. (James Pain and Sons.)	A squib ignited while being charged, and fired the composition in both compartments of Building No. 15. Three girls were slightly burnt. The cause appears to have been friction from getting the funnel choked with composition.	—	3	
79	11 Sept.	Detonator -	West Highland Railway, in course of construction, Killin, Perth.	A boy was scraping the inside of a detonator, and the resulting explosion necessitated the amputation of two fingers and part of the thumb of one of his hands.	—	1	X 44118
80	19 Sept.	Gunpowder	Clarendon Place, Dover.	A boy obtained some gunpowder from a flask. He placed the gunpowder in a tin on the pavement, and was seriously injured by the explosion which followed his dropping a lighted match into it.	—	1	
81	21 Sept.	Firework composition.	Eastbourne, Theatre Royal.	A canister of firework composition, used in producing the lightning in the storm scene, became ignited. The footlights were put out and the chimneys smashed, the glass cutting a gentleman in the face. The scenery caught fire but was promptly cut away and the flames extinguished. The man engaged in producing the lightning had an arm and a leg fractured, and his hand was severely injured. Several other persons were slightly burned.	—	3	
*82	25 Sept.	Ammunition, safety cartridges.	Room in connection with Registered premises, No. 1,411, Gloucester. (T. Page Wood and Company.)	A lad was slightly injured in the face by the explosion of two charges of powder whilst engaged in ramming home wads in a cartridge-filling machine called the "Erskine."	—	1	
83	3 Oct.	Firework composition.	Factory No. 57, Surrey. (Joseph Wells and Company.)	Four lads were charging fireworks in Building V, when a "golden rain" ignited in the hand of one of them. This lad was uninjured, but the other three were burnt more or less severely. The shed was burnt out. It seems probable that the accident was caused by some foreign matter having been present in the composition (which is not normally of at all a sensitive character), and such foreign matter may have consisted of gritty particles (accidentally introduced after the final sifting), or of some particles of some more sensitive composition remaining over on the benches, or present accidentally in the sieve. It is proper to state, however, that the manufacturers express their opinion and give reasons in support of such opinion, that the accidental presence of any chlorated composition would have been impossible in this case.	—	3	

* *See* No. 75/1893.

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons		Home Office Registry No.
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	1893.						
84	3 Oct.	Fog signal -	Factory No. 65, Kent. (The Henry Rifled Barrel, Engineering and Small Arms Company, Limited.)	A fog signal exploded in the press in No. 19 shed without doing any injury.	—	—	
85	11 Oct.	Gunpowder	34, Craddock Street, Spennymoor, Co. Durham (in the house of a coal miner named Thomas Smiles).	A spark from a match fell into a small barrel containing about 3 lbs. of powder (which was kept stored in the pantry for use in the mine). The back outer wall of the house was blown down, and the son of the occupier was severely burnt about the hands, arms, and back of neck.	—	1	
86	18 Oct.	Detonator -	Scotstoun, Renfrew	A boy (aged 11) obtained a number of detonators near the new railway station at Whiteinch. After giving a few away to some other boys he took the remainder home. He sat down by the fire and commenced to hammer one with the poker. The explosion which followed blew off a portion of the thumb and forefinger of his right hand, and also inflicted a wound on his left leg above the knee. It is supposed that the detonators were brought out of the tunnel or underground railway in the wagons and emptied over the embankment with the earth.	—	1	
*87	6 July	Fireworks (coloured fire). Sulphur-chlorate mixture.	Manchester, Sheffield, and Lincolnshire Railway.	A professor of chemistry (Mr. Thompson) was carrying with him a mixture intended for producing a coloured fire ("Bengal fire"), on the occasion of the Duke of York's wedding. The mixture was being carried in a bottle placed in a leather bag, on the middle seat of the compartment of a first-class carriage, when, just as the train was being pulled up, the explosion occurred, and the three passengers in the compartment, including Mr. Thompson himself, were injured. The composition, it appeared, contained unwashed flowers of sulphur and chlorate of potash, and was an undoubted and very interesting and instructive case of spontaneous ignition, the risk from which, in the case of mixtures of this sort, has long been recognised and frequently called attention to by the chemical adviser of this Department. Although the whole case was attended with various illegalities, the railway authorities consented, under the circumstances, and at the earnest request of Mr. Thompson, to withdraw proceedings.	—	3	
88	27 Oct.	Gunpowder	Factory No. 13, Bassinghyll, Westmoreland. (Messrs. W. H. Wakefield and Co.)	Mill No. 8 exploded on a 60 lb. charge, after being run for 40 minutes. No one was injured, and the mill building was only slightly damaged.	—	—	

* This case illustrates very usefully a point on which we have laid some stress in another part of this Report, in connexion with firework accidents (*see* p. 33).

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	1893.						
89	23 Sept.	Roburite -	Burton Wood, Newton - le - Willows, Lancashire.	During the wedding festivities of the mining surveyor at Collins Green Colliery, the storekeeper appears to have given out a number of Roburite cartridges to the men employed about the pit, to let off in honour of the occasion; one man (John Rothwell) had his right hand blown off.	--	1	
90	22 Oct.	Detonator -	Crail - -	A labourer had his left hand severely shattered by the explosion of a detonator, to which he had applied alighted fuze. It appears that he and two other young men broke into a lockfast box at Sauchope Links, in the parish of Crail, and obtained therefrom several dynamite cartridges and detonators. The box in question belonged to a general dealer, who had obtained a police certificate from the chief constable to keep explosives in it for use in breaking up the steamship "Pladda," which was wrecked at Sauchope Links. The certificate having expired on 31st May, the dealer was prosecuted and fined 5*s*., or one day's imprisonment, for keeping the explosive without a certificate.	—	1	X 44731
91	2 Nov.	Cartridge -	Dover - -	Two lads found a brass cartridge on the beach at the back of the South-Eastern Railway Station, near Shakespeare's Cliff. They began hammering it, with the inevitable result of an explosion following. They were both severely injured. One had the thumb of his left hand blown off, whilst the other had his legs injured. The cartridge appears to have been on board a yacht (the "Spitfire") which was wrecked near the spot where the boys found the cartridge, and was intended for use with a long range wild fowl gun fixed on a swivel. The charge of such cartridges consists of 6¼ ozs. shot and 1¼ ozs. powder; but as there were no shots found in the injured boy's leg, and as the boys themselves state that they found nothing but wads and powder in it, it is probable that the cartridge was an incomplete one in the sense of being unshotted, and to this cause the comparatively slight injury sustained by the boys may be regarded as due.	—	2	
92	4 Nov.	Gunpowder	In the street at Gelli, near Ystrad, Glamorganshire.	A boy, named Idris Cox, was badly burnt about the chest by an explosion of gunpowder. It appears that a lad, aged 11, purchased 1 lb. of powder in a shop, and Cox bought it from him, putting it in his outside breast pocket. They were letting off fireworks in the street, when a squib struck Cox on the breast, and ignited the powder. Prosecutions were instituted by the local authority, and the dealer was fined 2*l*. for selling gunpowder to a child under	—	1	

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	1893.		In the street at Gelli—*cont.*	13 years of age, and the boy who threw the squib which struck Cox, was fined 5*s.* for letting off fireworks in the public street.			
93	6 Nov.	Gelatine dynamite.	Scot Hay, near Silverdale, in a dwelling - house occupied by Charles Poulson.	On Saturday the 4th November a collier placed a tin canister containing 1 lb. of gelatine dynamite in the oven boiler to thaw, and he forgot to remove it. The boiler, it appears, being out of repair contained no water at the time. On the Monday following the explosion occurred, killing his wife on the spot, fatally injuring himself, and slightly injuring his brother.	2	1	
94	11 Nov.	Gunpowder	On board the British barque "Loch Sloy," at No. 1 Buoy, Greenock.	The "Loch Sloy," a British barque, bound for Adelaide, was taking in 20 tons of gunpowder at No. 1 buoy, Tail of the Bank, and after 10 tons had been stowed away in the magazine in the main-hatch, it was found that the vessel was on fire. After some little time and trouble were expended in discovering its source, it was found to have proceeded from the woodwork at the back of the range in the galley becoming ignited by the flame passing through a small hole in the iron protecting plate at the back of the range (within a couple of feet of the main-hatch). Fortunately the fire was extinguished in about 25 minutes, and with but little damage to the vessel. But it nevertheless revealed a new source of danger by the failure of the sheet-iron to protect the woodwork from ignition by the flames of the cooking range fire. It was clear that the promptness with which the fire was extinguished prevented an explosion almost similar to that which occurred at the same spot on board the "Auchmountain," in September 1892. Steps have been taken in connexion with the Board of Trade and the occupiers of floating magazines to prevent a recurrence of such accidents in future.	—	—	
95	22 Nov.	Experimental	Factory No. 3, Ayr. (Nobel's Explosives Company, Limited.)	During the testing of an experimental powder which was in process of manufacture, a portion of the rifle which was being used for this purpose burst, but no one was injured.	—	—	
96	9 Nov.	Blasting gelatine.	Westfield Limestone Mine.	A miner was charging a hole with five cartridges of blasting gelatine. He broke the first cartridge in two, dropped one portion into the hole, and proceeded to push it down with an iron cleaner or scraper. When near the bottom of the hole the gelatine stuck, and on his trying to force it down with the cleaner it exploded. The cleaner was blown out of the hole and struck him on the right breast, slightly injuring him.	—	1	X 45018

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons		Home Office Registry No.
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97	1893. 26 Nov.	Gelatine dynamite.	Bwlchglas, Cardiganshire.	Three men were injured through an explosion while charging a hole with gelatine-dynamite, one of whom succumbed to his injuries. The accident was supposed to have been due to the use of too much force in forcing home the cartridge with the wooden rammer.	1	2	
98	17 Nov.	Fireworks -	Registered premises, No. 2,354, Middlesex. 30, Popham road, Islington. (Mr. E. Gatland.)	The premises consist of shop and parlour, with two rooms over. In the room over the shop about 15 lbs. of fireworks (Chinese crackers, fairy fountains, &c.) had been put away in a cupboard. The apartment was used as a bedroom, and no fire had been lighted there for two years. A boy, aged 16, was in charge of the premises that evening, and about 9.15 p.m., a neighbour opposite, observing the room on fire, gave an alarm. The fire was extinguished, but the fireworks had been burned; and from the appearance of the cupboard, the fire must have originated there. But as there were no coloured fires present, it is not assumed that the accident was due to spontaneous ignition. It may, however, have been due to the lad dropping a light amongst the fireworks, but he denied having entered the room.	—	—	
99	20 Nov.	Gelatine dynamite.	Dunnikier Colliery, Kirkcaldy.	A miner was slightly injured in the side by some flying débris during the firing of a shot.	—	1	X 45146
100	6 Dec.	Ballistite -	Adjoining Factory No. 125, Cumberland. (Sir W. G. Armstrong, Mitchell, & Co., Limited.)	During experiments with a 9 c.m. breech-loading gun, the breech screw, carrying with it the rear portion of the breech-piece, was blown out, a portion of which struck a fitter (named English), killing him instantly. The man, it appears, had received instructions, *before* the gun was fired, to carry out some work in connexion with the mounting of another gun, to be done *after* the present experiment was over, and he, probably mistaking the instructions, started off there and then to carry them out, and was just in rear of the gun when the accident occurred.	1	—	
101	6 Dec.	Fog signal -	Factory No. 65, Kent. (The Henry Rifled Barrel Engineering and Small Arms Co., Limited, Woolwich Road, East Greenwich, S.E.)	A fog signal exploded in the press in No. 19 shed, without doing any injury.	—	—	
102*	13 Dec.	Dynamite -	Sutton Harbour, Plymouth.	During the operation of deepening the harbour for the reception of larger vessels, and whilst blasting operations were being carried on from a "flat" or barge, an explosion occurred, by which two men were killed and one man slightly injured. From the result of the inquiry, it appeared that,	2	1	X 53282

* Compare with Accident 3.

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons		Home Office Registry No.
					Killed.	Injured.	
	1893.		Sutton Harbour, Plymouth—*cont.*	at the time of the explosion, the charge remained in the iron pipe through which it is conveyed to the rock, instead of being deposited in the bore-hole prepared to receive it. The coroner's jury returned a verdict of accidental death. (*Inquiry and Special Report CVI.*)			
103	13 Dec.	Fireworks (Socket distress signal).	On board the S.S. "Rose," plying between Holyhead and Dublin.	The steamer "Rose" broke down when about 15 miles from Holyhead, during very stormy weather, and several socket distress signals were fired (to attract the attention of passing vessels); these acted properly. Another signal, however, on being fired, failed to ascend, and fell on the main deck and exploded, inflicting fatal injuries on a fireman, and slightly injuring one of the deck passengers. The damage done to the vessel was of a very slight character. It was doubtful in this case whether the failure was due to the signal being blown back by a squall or to it being unsufficiently rammed home, or to the charge in the base of it having become damp. Some former accidents (as notably those on the "City of Paris" and the "City of Chicago," *see* Annual Report, 1891, page 38, were attributed to the propelling charge having become damp; and the instructions issued by the Board of Trade to the Surveyors call particular attention to the necessity for periodical renewal of signals to obviate this possible cause of accident. (Regulations for Survey of Steamships carrying Passengers, 1893, clause 73.)	1	1	
104	20 Dec.	Fog signal -	Factory No. 7, Kent. (Cotton Powder Co., Limited.)	A fog signal exploded in the press without causing any injury.	—	—	
105	22 Dec.	Percussion cap composition.	Factory No. 58, Waltham Abbey, Essex. (Messrs. Joyce & Co., Limited.)	An explosion occurred in the mixing shed No. 45 during the process of mixing cap composition for B.L. central-fire caps, inflicting severe injuries on the mixer, and after an interval of about half a minute, another explosion of a quantity of mixed cap composition in a gutta-percha bottle, standing on the floor of the shed, followed, causing injuries to four other persons. The mixer and one of the men injured by the second explosion afterwards died. The origin of the first explosion was not ascertained, but there can be no doubt that it occurred during the operation of mixing (by means of a sieve) on a table behind a screen. The injuries sustained by the mixer in this explosion were probably aggravated by the second explosion, which occurred near to where he lay. The total quantity exploded certainly did not exceed 3 lbs., and may have been only 2 lbs. (*Inquiry and Special Report CVII.*)	2	3	

Index No.	Date of Accident.	Nature of Explosive.	Where Accident occurred.	Cause of Accident so far as ascertained.	No. of Persons		Home Office Registry No.
					Killed.	Injured.	
106	1893. 1 Dec.	Gunpowder	Hundhill Quarry, East Hardwick, near Pontefract.	The deceased and another man were preparing a blast in an open quarry, when a red-hot cinder from an engine of a crane on the top of the quarry ignited the charge, causing an explosion by which both men were injured. The other man has recovered.	1	1	X 45450
107	27 Dec.	Detonator -	No. 33, Oil Shale Mine, Limefield, West Calder.	A drawer in a mine was injured in the left hand by picking with some sharp instrument the composition of a detonator which had been withdrawn from a charge in consequence of a miss-fire. A miner had placed the detonator on one side, intending to take it out of the mine and destroy it, when Main observed it and took it to another part of the mine, where the accident happened.	—	1	X 45508
108	18 Nov.	Gunpowder	Mansfield village, New Cumnock.	A collier started to go to his work at 5 a.m., but, owing to a breakdown on a colliery railway, was unable to reach the pit and returned home, putting two tin cans, one containing tea and the other containing gunpowder on the table. He then sat by the fireside, with his son eight years of age, and put one of the cans, supposing it to be that containing the tea, by the side of the fire. Shortly afterwards an explosion occurred, and both he and his son sustained severe injuries, the latter dying on the 3rd December. The house, also, was much damaged.	1	1	X 45503
109	21 Feb.	Carbonite -	East Hetton Colliery, Durham.	A collier was injured in the right hand by the explosion of the electric detonator whilst he was ramming the charge with a wooden "beater."	—	1	
110	18 May	Gelatine dynamite.	Weardale Lead Mine, Stanhope.	As the miner was inserting the pricker into a hole that had miss-fired, he struck the detonator and the shot went off, injuring one of his eyes, and taking off the little finger of his left hand.	—	1	
111	13 Oct.	Gunpowder	Sherriff's Pit, Rosedale, West Yorkshire.	A miner was fatally injured by returning too soon, viz., before the shot had exploded. He is supposed to have mistaken another shot for the one he meant to avoid.	1	—	
112	24 Nov.	Carbonite -	Wheatley Hill Colliery.	The injured man lighted two shots, and thinking afterwards that he had only lighted one, he returned, and the second shot went off in his face just as he was examining it, and seriously injured him.	—	1	
113	21 Nov.	Dynamite -	Sourton Quarry, near Okehampton, Devonshire.	The deceased was ramming a charge of dynamite with an iron rod. The resulting explosion inflicted injuries on him, to which he succumbed on 13th January following. The use of an iron rod was contrary to the regulations.	1	—	X 45677

APPENDIX X.

Accidents in Thawing Dynamite.

United Kingdom.

No.	Date.	Place.	No. of Killed.	No. of Injured.	Total No. of Casualties.	Remarks.
1	Winter of 1871-72	Wheal Agar Mine, near Pool, Cornwall.	—	—	—	Some cartridges which were being thawed in the dry house of the mine round the stove exploded and blew the roof off.
2	9 Oct. 1872 -	Chwarel Fawr Quarry, near Carnarvon.	2	—	2	The deceased were thawing dynamite on a stove in the weigh house.
3	9 Dec. 1872 -	Cottage at Luxulion, Cornwall.	1	6	7	Thawing dynamite in front of a kitchen fire.
4	10 Dec. 1872 -	Fowey, Cornwall -	—	1	1	Similar accident.
5	10 June 1873 -	Frizington, Whitehaven.	—	—	—	A man put a packet of dynamite into a cottage oven to thaw it. House wrecked. No one in the room at the time.
6	10 Feb. 1874 -	Airesland, Wigtown -	—	1	1	The injured man was thawing dynamite on a shovel.
7	— Aug. 1873 -	Airyhemming -	—	2	2	Similar accident.
8	12 Feb. 1875 -	Eston, Cleveland -	2	—	2	Dynamite placed near fire to thaw.
9	23 Feb. 1875 -	Mountain Ash -	1	2	3	Dynamite placed in oven to thaw.
10	— — 1874 -	Avonmouth, Bristol -	—	—	—	Dynamite thawed in a chest by steam not under pressure exploded. This is a curious instance of explosion by exposure to heat not exceeding 212° F., and was probably, result of decomposition in the first instance.
11	17 Nov. 1875 -	Llanbedrog Quarry, Pwllheli.	1	3	4	Thawing dynamite on a shovel.
12	1 May 1876 -	Morrisonshaven, Prestonpans.	1	2	3	Man put a "warmer" containing dynamite on a smithy fire and blew the bellows. The warmer was a canister in a kettle of water.
13	26 Nov. 1877 -	Minera Mine, Wrexham.	—	1	1	Man thawing dynamite at a candle. Left hand shattered.
14	24 Jan. 1878 -	Caermincian Quarry, Llanberis.	2	—	2	Thawing dynamite by a fire. One of the men was blowing a bellows at the time.
15	23 Jan. 1878 -	Dinorwic Quarries, Llanberis.	—	1	1	Man warming three primers of dynamite on a stove.
16	4 Dec. 1878 -	Letterwood, Oban -	2	—	2	Thawing dynamite in water (or in a tin in water) over a fire.
17	21 Dec. 1878 -	Talargoch Mine, Rhyl	1	1	2	Heating dynamite in a tin over a candle.
18	9 Jan. 1879 -	Halkyn, Flint -	—	—	—	Dynamite exploded while being thawed in a manure heap heated by a steam-pipe. Compare No. 10.
19	29 Jan. 1879 -	Newcastle-on-Tyne -	—	3	3	A small vessel inside a metal bucket was being used for thawing dynamite. An explosion took place when the water was heated on a fire, probably through accidental presence of dynamite in the water.
20	29 Jan. 1879 -	Festiniog -	—	2	2	Thawing dynamite before a cottage fire.
21	13 Feb. 1879 -	Lochcarron - -	1	—		Man killed in re-heating some water used for thawing dynamite, with which it must have come into contact. Compare No. 19.
22	21 March 1879 -	Low Hale Colliery, Wigan.	—	3	3	Men thawed dynamite in water and threw the water under the grate. The water which contained nitroglycerine naturally exploded, and the explosion was communicated to other cartridges on the floor. Compare Nos. 19 and 21.
23	14 April 1879 -	Praze, Cornwall -	2	—	2	Thawing dynamite before a fire.
24	19 June 1880 -	Glencruitten, Oban -	—	2	2	Similar to 19. The inner can had a hole in it.
25	4 March 1880 -	Craig, Montrose -	5	1	6	Explosion of a kettle containing water from a warming pan, in the inner casing of which there was a hole. Compare Nos. 19, 21, 22, 24.
26	5 Apr. 1880 -	Hawkesbury Colliery, Bedworth.	1	—	1	Re-heating water in which dynamite had been thawed. Compare Nos. 19, 21, 22, 24, 25.
27	1 Dec. 1880 -	Great Pant-y-Pydew Mine.	—	2	2	Dynamite put on a hob to thaw.
		Carried forward -	22	33	55	

No.	Date.	Place.	No. of Killed.	No. of Injured.	Total No. of Casualties.	Remarks.
		Brought forward -	22	33	55	
28	18 Jan. 1881 -	Berehaven Mines -	2	3	5	Dynamite put on a hot iron tube to thaw.
29	15 Feb. 1881 -	Beath, near Kelty -	—	1	1	Man rubbing two cartridges of dynamite together in his hands to complete thawing.
30	1 May 1882 -	United Phœnix Mines, Cornwall.	—	1	1	Thawing dynamite over a candle.
31	26 Jan 1883 -	Glascoed, Llanbaddock.	—	3	3	Man put dynamite into an oven to thaw.
32	2 March 1883 -	Tunnel, near Bangor -	1	—	1	Thawing dynamite near a fire.
33	29 March 1883 -	Southrigg Colliery, Airdrie.	1	1	2	Dynamite placed to thaw in extemporised warming pan in hot ashes. Probable leak in inner tin or no water between inner and outer tins. Compare Nos. 19, 21, 22, 24, 25, 26.
34	2 April 1883 -	South Phoenix Mine, Cornwall.	—	3	3	Thawing dynamite near a hot iron tube. Compare No. 28.
35	8 Nov. 1883 -	Plumbley Colliery, Eckington.	1	1	2	Dynamite placed under a fire on a pit bank to thaw it.
36	7 Nov. 1883 -	Rhondda Merthyr Colliery, South Wales.	—	2	2	Thawing dynamite near fire.
37	7 Nov. 1883 -	Greengairs, Airdrie -	2	2	4	Dynamite placed on a hob to thaw.
38	17 Dec. 1883 -	Cardenden Colliery, Fifeshire.	—	1	1	Thawing dynamite on a piece of tin over a lamp.
39	17 Dec. 1883 -	Town Hill Colliery, Dunfermline.	1	1	2	Similar accident.
40	3 Nov. 1883 -	Pumpherston Oil Works, Mid Calder.	—	1	1	Thawing dynamite in his hand before a fire.
41	18 Dec. 1884 -	Holywell, Flint -	—	2	2	Thawing dynamite in a tin before a fire.
42	2 Jan. 1885 -	Carrickfergus -	1	—	1	Man holding dynamite to thaw before a fire.
43	1 April 1885 -	New Inn, Rhondda Valley.	2	1	3	A man put dynamite to thaw in a saucepan and then into an oven.
44	31 March 1885 -	Halifax - -	1	1	2	Man thawing dynamite before a boiler fire or picking at it when hot.
45	8 Jan. 1886 -	Camps Lime Works, Kirknewton.	—	3	3	Thawing dynamite in a tin before a fire.
46	12 Jan. 1886 -	Mancetter Bridge (Oldbury) Quarry, Atherstone.	1	—	1	Thawing dynamite in a tin over a fire.
47	20 Jan. 1886 -	Railway in course of construction near Clonakilty, co. Cork.	1	—	1	Blasting gelatine placed in a tin kettle near a fire and either a boy (killed) meddled with it or it became overheated.
48	19 March 1886 -	Butterton, near Leek -	1	1	2	Gelatine dynamite put in an oven to thaw.
49	9 April 1886 -	Craven Moor Lead Mine, Pateley Bridge, Leeds.	1	—	1	Thawing dynamite over a candle.
50	8 Nov. 1886 -	Raisby Hill Quarries, Durham.	—	1	1	Thawing dynamite in front of a fire.
51	8 Jan. 1887 -	Railway in course of construction at Ballintubber, co. Wexford.	3	—	3	Man placed can containing dynamite and water on fire.
52	12 Jan. 1887	Railway in course of construction at Ballintubber, co. Wexford.	—	—	—	Man placed can containing dynamite and water on fire.
53	13 Jan. 1887 -	E. Romans Mine, Shropshire.	—	3	3	Man placed can containing dynamite and water on fire.
54	27 April 1887 -	Quarry at Worrall, near Bradfield.	—	5	5	Throwing dynamite on hot shale close to a fire.
55	12 Nov. 1887 -	Barry Railway, near Cardiff.	1	—	1	Thawing dynamite in a metal can over a fire.
56	16 Jan. 1888 -	Ratcleugh Quarry, near Alnwick.	1	—	1	Carrying dynamite in a bucket of hot ashes.
57	29 Feb. 1888 -	Bolts Burn, Rookhope, Durham.	1	—	1	A cartridge of gelatine dynamite left in pocket of trousers which were hung to dry before the fire.
58	16 March 1888 -	Melyn Tin Works, Neath.	1	—	1	Kneading dynamite placed to thaw on hot cinders.
59	17 Dec. 1888 -	Pencoed, Llanelly -	2	1	3	Thawing dynamite in a bucket over a fire.
66	13 Feb. 1889 -	Pentrebach, Old Iron Works, near Merthyr.	1	—	1	Thawing dynamite in a metal can on or near hot cinders.
61	23 Feb. 1889 -	Cwm Mawr Mine, Merioneth.	—	1	1	Boiling dynamite with water in a can over a fire.
62	5 Feb. 1890 -	Burradon - -	—	4	4	Thawing dynamite n a can of water placed in an oven.
63	18 Feb. 1890 -	Colwill Quarry, near Egg Buckland, co. Devon.	2	—	2	Thawing dynamite by steaming it in an old straw hat placed over hot water containing nitro-glycerine.
		Carried forward -	50	76	126	

No.	Date.	Place.	No. of Killed.	No. of Injured.	Total No. of Casualties.	Remarks.
		Brought forward -	50	76	126	
64	— March 1890 -	Moss Bay Iron Company's Works, Maryport.	1	1	2	A man put about 5 lbs. of dynamite on stove and 60 more cartridges before fire. He was under the influence of drink at the time.
65	4 July 1890 -	Bonnyside Fireclay Mine, Bonnybridge, Stirlingshire.	—	1	1	A man was engaged in heating water for thawing dynamite, which had previously been used for that purpose, when an explosion took place.
66	26 Nov. 1890 -	Radyr Quarry, Llandaff.	2	1	3	A man thawed dynamite in a bucket of water, and then put the dynamite into a proper warming pan and filled up the outer case of the pan with water from the bucket. Some time afterwards another man, in ignorance of what had been done, put the water from the outer casing of warming pan into a bucket and placed it on the fire to heat. An explosion immediately took place.
67	9 Jan. 1891	Creagmore House, Kilmakie, Inverness-shire.	2	2	4	Some blasting gelatine cartridges were put into a canister which was placed into a kettle on kitchen fire.
68	19 Dec. 1891 -	Navigation Sinking Pits, near Pontypridd, Glamorganshire.	—	2	2	Some water, which had previously been used for thawing dynamite, was put into a tea kettle. The water is supposed to have contained nitro-glycerine. There is said to have been a leak in the warming pan.
69	16 Jan. 1892 -	18½, Bute Town, Ponttottyn, Merthyr Tydvil.	—	1	1	Two dynamite cartridges placed in an oven.
70	27 Feb. 1892 -	Penrhiewfer Colliery, near Dinas.	3	—	3	Thawing dynamite in a tin over a paraffin lamp.
71	23 Feb. 1893 -	Machine House of Mr. Lewis Thomas, Wern Colliery, Pontypridd.	—	2	2	Some dynamite cartridges placed on shovel over the fire to thaw them.
72	6 Nov. 1893 -	Scot Hay, near Silverdale.	2	1	3	Tin canister of gelatine dynamite placed in oven boiler to thaw.
		Total -	60	87	147	Each "accident," therefore, on an average, killed or wounded two persons.

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RETURN to an Address of the Honourable The House of Commons, dated 9 August 1894;—*for*,

"COPY of Report by Professor *Dixon*, Member of the Royal Commission on Explosions from Coal Dust in Mines, on the recent Explosion in the Albion Colliery, South Wales."

The Victoria University, Manchester,
6 July 1894.

REPORT on the Explosion at the Albion Colliery.

ON 4th July, eleven days after the explosion, I made an examination of the Albion Colliery, near Pontypridd. Although it was not possible to examine all the workings, I have come to certain conclusions, which may be modified by the results of subsequent exploration, but are, I think, in the main correct.

The facts of the explosion appear to be strikingly similar to those at Seaham, the flame having traversed nearly all the main roads on both sides of the shaft.

The four-foot seam of steam coal is worked at the Albion Colliery on the long-wall system. From the down-cast shaft (19 feet in diameter) nearly straight roads run north west and south-east. The north-west road, called Grover's Level, sends out a branch to the west called Dudson's Level; and the south-east road sends out a branch to the east called Panddu Dip, and another to the south called Bodwenarth Incline. On entering Grover's Level from the shaft the force of the explosion is plainly seen to have been exerted towards the shaft. For several hundreds of yards props are bent outwards, and small refuges places built of stone are partially thrown outwards. Doors into the return are blown towards the return. At or near a certain spot I will call the First Fall, the direction of the force changes. Near this Fall little violence was exerted, and the men found there were burnt, but not mutilated. About 100 yards inside the First Fall much violence was exerted; the bodies of the men found were mutilated, and all the indications show the flame travelled inwards and reached the working faces. In Dudson's Level, which branches to the west from Grover's Level, about half-way between the shaft and the First Fall, the indications of force are unmistakedly *inwards*. The flame must have entered Dudson's Level from Grover's Level. I am informed that the flame travelled along Dudson's Level until it reached a dust free part and was there extinguished. Thirty-seven men were found together in the workings out of Dudson's Level. They had evidently tried to find their way out. They were not burnt, but killed by after-damp.

Returning to the downcast shaft and crossing it to the south-east level I found indications of force coming *from the level towards the shaft*. These marks did not indicate great violence and only extended inwards about 80 yards. Going further in, I found the indications of force were all *inwards*. The explosion had travelled inwards down Panddu Dip for about 170 yards. Then a wet length of road stopped the explosion. The damp portion was about 110 yards long when I traversed it; possibly the water had accumulated since the explosion. Beyond this wet portion the road was dry and dusty, but the explosion had not reached it. Men and horses in the workings beyond were rescued alive. The men had only felt a rush of air. Along the main level and the Bodwenarth Incline the explosion appears to have travelled to the working faces, although some water was lying in the latter road. I did not explore this incline; the length of wet road should be measured.

So far as I can form an opinion all the evidence points to the explosion originating in Grover's Level at some point between the small opening called

the Pump Hole, 40 yards outside the First Fall, and Llanfaber's Dip, about 120 yards inside the First Fall. From this region the flame passed inwards towards the face and outwards towards the shaft, entering Dudson's Level on the way. On reaching the downcast shaft the compressed air wave would find a vent in the shaft itself. The roads near the bottom of the shaft were not so dry as further in. The flame would pass with moderated intensity into the south-east level across the shaft, gradually becoming more intense as it traversed the dust-laden road. To the right hand it blew in doors leading to the return, and probably extended in the return to the bottom of the upcast shaft. To this explosion wave in the return I attribute the damage done to the boiler-room near the downcast shaft between the return and the south-east level. The marks of violence *towards* the shaft found near the entrance to the south-east level are either due to a wave of air propagated backwards when the explosion had again gathered strength, or to one of those oscillations of the flame which are seen in laboratory experiments and whose effects have often been observed in explosions in mines.

Concerning the fuel by which the explosion was propagated through the mine, I am quite satisfied that sufficient dust was lying in a dry and fine state along the main roads to feed the flame throughout the parts penetrated by the explosion. The coal gives off gas, but no accumulations of gas had been observed. The return air tested at the junction of the return roads from Grover's and Dudson's Levels showed 1¼ per cent. of fire-damp present. I do not see how it is possible for fire-damp to have accumulated in the main intake air-roads or to have been introduced suddenly into them in sufficient quantity to feed an explosion throughout the extent of road actually traversed by the flame. There can, in my opinion, be no question that the explosion throughout its main extent was a pure dust explosion.

Concerning the origin of the explosion I cannot speak with certainty, but I have formed a strong opinion. Since the explosion appears to have originated in Grover's Level, the question naturally presents itself, are there any circumstances pointing to an accumulation of gas or to a dangerous shot having been fired within the limits referred to between the Pump Hole and Llanfaber's Dip? At the place I have called the First Fall it was necessary to remove some of the props supporting the roof. This was generally done by boring a hole in the prop near the floor and firing a dynamite cartridge in it. Sometimes a shot was fired in the corresponding prop and also in the cross-piece. The two props are locally called "arms" and the cross-piece the "collar." Some distance beyond the First Fall was a second place where the props had to be removed, and there the cartridges were found placed in holes in the "arms" with cap and fuse ready fixed for firing. Forty yards out from the First Fall, in the recess known as the Pump Hole, three men were found dead. They were the overman, fireman, and chargeman; they were burnt but not mutilated. The fireman, I am informed, had caps in his pocket. Beyond the First Fall the two timbermen were found. They had left their cans in a refuge hole ten yards from the fall, and had apparently moved a yard or two outwards after the explosion. They were lying on their faces, their lamps by them. As I have said, but little damage was done on either side of the First Fall, which is precisely what would have happened had the explosion originated there. It is now well-established that an explosion starts gently and increases in violence after it has travelled a certain distance from its point of origin. The fireman and timbermen were found in positions consistent with the view that they had just fired a shot at the First Fall. At my request the props at the First Fall were marked and taken to the surface together with others in which shots had been placed. Near the extremity of one of the "arms" from the First Fall the wood was splintered and certain marks were observed on it. Either the arm had been splintered by the fall or by the explosion of a cartridge in it. I had several dynamite shots fired in similar baulks of wood and in every case part of the hole was left, widened and split, but showing the marks of the augur. On comparing the marks with those on the arm from the First Fall I am strongly of opinion that a dynamite shot had been fired in the latter, and that this was the origin of the explosion. It is not likely that any dangerous quantity of gas could have existed in the air-current at this point in the intake air-road, where the ventilation was abundant. If there had been a sudden blower, it would have been observed and an alarm raised. As a matter of fact the overman and

fireman

fireman were found sitting in the Pump Hole. I carefully tested the highest cavities in the roof near the first fall for traces of fire-damp. Using the hydrogen lamp of Professor Clowes, I can be certain that the air in the cavities did not contain $\frac{1}{4}$ per cent. of fire-damp. If gas were gradually given off from the rock one would expect to find traces of it in the cavities above the roof. But even if gas had existed in the roof the flame from the shot, which was fired close to the floor, would not have reached it. I am driven, therefore, to the belief that the dynamite shot fired in the prop close to the dry dust on the floor raised a cloud of inflammable particles and set them on fire; and I think it likely that the flame from the dynamite was intensified by the stemming containing coal dust. Once a cloud of dust was ignited the explosion would extend in all directions so far as the dust itself on the roads extended.

One important point will no doubt be brought out at the official inquiry, viz., whether instructions were given to water the dust near shots, and whether such instructions, if issued, were acted upon. I saw no evidence that water had been used to lay the dust at the First Fall, and could not learn that watering had been adopted on this occasion. But I cannot speak with any certainly on this matter; the evidence must be sifted. The Company were aware of the dangerous nature of the dust; I found the water-pipes intended to damp the dust by spray already extending some distance along the intake.

(signed) *H. B. Dixon.*

ALBION COLLIERY EXPLOSION
(REPORT).

COPY of Report by Professor *Dixon*, Member of the Royal Commission on Explosions from Coal Dust in Mines, on the recent Explosion in the Albion Colliery, South Wales.

(*Mr. Chamberlain.*)

Ordered, by The House of Commons, *to be Printed*,
14 *August* 1894.

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SOLENT EXPLOSION.

No. CVIII.

REPORT

TO

THE RIGHT HONOURABLE THE SECRETARY OF STATE FOR THE HOME DEPARTMENT

ON THE

CIRCUMSTANCES ATTENDING AN EXPLOSION OF TONITE OR COTTON POWDER

WHICH TOOK PLACE IN

THE SOLENT

On the 19th July 1894;

BY

COLONEL A. FORD,

H.M. INSPECTOR OF EXPLOSIVES.

Presented to both Houses of Parliament by Command of Her Majesty.

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1894.

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REPORT

TO

THE RIGHT HONOURABLE THE SECRETARY OF STATE FOR THE HOME DEPARTMENT.

ON THE

Circumstances attending an Explosion which took place in the Solent, on the 19th July 1894;

BY

COLONEL A. FORD,

H.M. INSPECTOR OF EXPLOSIVES.

Home Office,
30th July, 1894.

SIR,

I HAVE the honour to report that in obedience to your Order of the 23rd July (X48634/2), made under the 66th section of the Explosives Act, 1875, I have held an Inquiry into the circumstances attending an explosion (No. 49 of 1894) of tonite or cotton powder which occurred in the Solent on the 19th instant in a boat belonging to the corporation of the Trinity House. By this explosion seven men lost their lives.

Removal of wrecks.

The Trinity House, an ancient Corporation, dating from 1514, in addition to performing other duties, is the general Lighthouse Authority for England and Wales, and, as such, is empowered by the Wrecks Removal Act of 1877 (40 & 41 Vict. chapter 16) to raise, remove, or destroy vessels sunk, stranded, or abandoned in any fairway, or on the sea shore. For the destruction of wrecks, stores of explosives are kept at different points, and, ordinarily, a diver in the employ of the corporation is sent to superintend the work. Occasionally, when the wreck is not in deep water, the services of the diver have not been called into requisition, and the dispersion has been effected under the direction of the "Trinity Superintendent" or local agent of the Trinity House in the particular district. The masters and men of the various lightships when on shore on relief from their vessels have usually been employed in assisting the diver or superintendent.

Wreck of the "Azalea."

On the night of the 4th July, 1894, a yawl of 10 or 11 tons, the "Azalea," ran aground on the Brambles, a shoal in the Solent, between Southampton and Cowes, and distant from the latter place about two miles. It could not be got off and was abandoned. In due course the corporation of the Trinity House were communicated with, and as the vessel was in shallow water, Mr. Josiah Gaster, the Trinity Superintendent for that district, suggested that he should be directed to effect the dispersion himself, adding that he had all that was necessary for the purpose. He had been in charge of this district for about 14 years, and had taken part in about 20 removals of wrecks, but, hitherto, the services of the diver had always been required, and none had been conducted entirely by himself. The necessary authority having been obtained from the Trinity House, Mr. Gaster proceeded to detail a party of six men, all on relief from lightships, to carry it out. They consisted of—

Party for dispersing the wreck.

Henry Clavell, aged 57, master of the "Nab" lightship to superintend.

William Samuel Cook,	36	Seamen of lightships.
Alfred Hutchings,	36	
Frederick Cotter,	22	
Alfred Snow,	23	
William Oatley,	22	

Explosives.

He had a supply of tonite or cotton powder in charges of various sizes from 5 to 50 pounds, contained in zinc cases, some electric detonator fuzes, and some safety fuze.

E 83139. Wt. 8893.

These explosives were of excellent quality, the best, in fact, of their kind; but the zinc cases were fitted with a collar or "gland" adapted for use only with electric detonator fuzes and not with ordinary detonators and safety fuze, and Mr. Gaster had no battery for firing the electric detonator fuzes:* in short, therefore, he had not all that was necessary, and with the appliances at his command he could not properly carry out the work. But instead of communicating again with the Trinity House and pointing out that he had no electric battery, and that the charges were not intended or adapted for firing with ordinary safety fuze and detonators, he attempted, in a preliminary trial with Clavell, to convert an electric detonator fuze into an ordinary detonator (that is to say, by removing the detonator from the head of the electric detonator fuze), and thus to use it with the safety fuze.

The gland of the case containing the charge is closed by two metal discs with an india-rubber disc between them; these are pressed tightly together by means of two screw nuts which work in a collar, and the india-rubber, being thus expanded, prevents the ingress of water into the charge. The metal discs have two holes for the two wires of the electric detonator fuze, and it happened that the safety fuze would just pass through those holes, but the detonator at the end of the safety fuze would not pass through. The india-rubber disc, which, as before stated, is compressed between the metal discs, has two corresponding holes, but they are not so large, being made smaller, with a view to preventing the electric wires, when passing through them, from coming into contact with the metal discs, and thus completing the circuit. As the safety fuze would not pass through these holes in the india-rubber disc one of them was enlarged with a penknife to enable it to do so. Below the discs there is a hole in the tonite forming the charge, to contain the detonator at the end of the electric detonator fuze; this is central with respect to the gland, while the two holes in the discs are equidistant from the centre. It will be seen that when the discs with the safety fuze passing through one of the holes were replaced in the gland, it was necessary to bend the safety fuze in order to put the detonator into the hole in the tonite at all. The other hole in the discs, which it was necessary to close to prevent water getting into the charge, was stopped by Russian tallow.

Mr. Gaster appears to have been quite satisfied with this arrangement; he was doubtless not aware that the detonator forming part of the electric detonator fuze was in itself not suitable for use with ordinary safety fuze, the composition being covered with tinfoil, which might prevent or delay the ignition of the detonator.

Operations on the "Azalea."

The Trinity House have a schooner, the "Mermaid," at Cowes, for carrying out reliefs of the light vessels and other duties in connexion with their work; and on the evening of the 17th July Mr. Gaster, after an unsuccessful attempt to relieve the "Needles" Lighthouse, owing to bad weather, started with the necessary explosives for Southampton Water, for operations on the "Azalea" at low tide early the next morning. The sea proved to be still too rough, and they returned to Southampton Water. On the morning of the 19th the weather had moderated, and they reached the wreck about 5 o'clock. The "Mermaid" was kept under weigh, standing off and on, and Clavell and the five men went on board a 20 ft. boat, the larger of two belonging to the "Mermaid," into which five charges of tonite, viz., one of 30 lbs., one of 20 lbs., one of 10 lbs., and two of 5 lbs. each (total 70 lbs.) were placed in a box with a loose lid. Clavell was supplied with six detonators obtained from electric detonator fuzes, which he put into one of his pockets, and three coils of double gutta-percha safety fuze. He had also some ordinary vesuvians for lighting the fuze. The box containing the tonite charges was placed on the bottom of the boat.

Circumstances of accident.

After they had started, Mr. Gaster followed in the smaller boat with two oarsmen; and when he had reached the wreck, and was about 10 yards from the larger boat, he directed Clavell to prepare a 20 lbs. charge. After Clavell had replaced the discs of the gland fitted with the fuze and detonator, as above described, and the collar had been screwed on, Mr. Gaster observed that one of the men who was uncoiling the fuze with a view to cutting it to the proper length was not doing so very carefully; the man was twisting it up, in fact, in small circles, and Mr. Gaster told him to do it more carefully. The fuze, when cut, was again coiled up and seized to the collar with spun yarn, and the charge was then lowered, also by spun yarn attached to the gland, to the deck of the wreck near the main-mast, where there was about four feet of water at the time. The length of fuze was about 12 feet, equal to a calculated time of burning of about four minutes. The fuze having been lighted, the boats withdrew to a distance, but the charge failed to explode. After waiting for some time—estimated

* When the diver attended he brought a battery with him.

by Mr. Gaster at about 25 minutes,—Clavell proceeded to prepare a 30 lbs. charge; and as the tide had been flowing, and the water would soon be too deep for them to see the wreck, Mr. Gaster told Clavell that in order to expedite the operations, he would go on board the "Mermaid" and himself get ready a smaller charge to complete the breaking-up after the 30 lbs. charge had been fired. Clavell then asked him whether he should recover the 20 lbs. charge which had failed to go off, and Mr. Gaster told him not to do so. While Mr. Gaster was on board the "Mermaid" the 30 lbs. charge exploded satisfactorily, and he took a 5 lbs. charge which he had prepared with the assistance of Alfred Rennie (22), an apprentice for the steam vessel service of the Trinity House, in the smaller boat towards the site of the wreck. Rennie accompanied him. Rennie had been transferred from another district, and had been specially recommended by his former chief as likely to be of use in blasting operations, as he had had considerable experience in that district. On reaching the site of the wreck where the other boat had previously arrived, Mr. Gaster remarked to Clavell that the explosion of the 30 lbs. charge had been satisfactory; and Clavell replied, "Yes, sir; " and I have recovered the 20 lbs. charge." Mr. Gaster then said, "Oh, have you?" (but without, apparently, reproving him for this disobedience of orders); and he asked him how far the fuze had burnt. Clavell replied, "Right up to the charge." Mr. Gaster gave no instructions as to the disposal of the recovered charge, which was then lying on the bottom of Clavell's boat, and he handed to Clavell the 5 lbs. charge which he had prepared; at the same time Rennie stepped into Clavell's boat. There were thus in Clavell's boat the six men above enumerated, and Alfred Rennie. When Rennie had got on board Clavell's boat he took up the charge which had failed to explode from the bottom of the boat, and placed it on one of the thwarts near himself. Mr. Gaster, from his position in the other boat, was able to see the charge, and noticed that there was no fuze then attached to it. The 5 lbs. charge was now placed in position near the mizen-mast of the wreck, which was still standing, and the fuze lighted, the boats withdrawing as before. After the 5 lbs. charge had gone off, and the boats were returning to the site, Clavell's being about 10 yards in advance of Mr. Gaster's, an explosion occurred in Clavell's boat, and two of the seven men it contained and the boat itself were blown to pieces. Clavell also and two of the men (Snow and Cotter) were killed instantaneously, and the remaining two (Cook and Hutchings) were terribly injured; both died shortly afterwards on board the "Mermaid," to which they were taken when picked up as soon as possible by Mr. Gaster. Mr. Gaster, who was standing in the stern of his boat with the yoke lines in his hand, at the moment, and the two oarsmen in his boat, were all uninjured, although only about 10 yards off.

Cause of accident.

It will be remembered that five charges in all—viz., one of 30 lbs., one of 20 lbs., one of 10 lbs., and two of 5 lbs.—had been put into the boat. They were contained in a box with a loose lid, and doubtless the 10 lbs. and the two 5 lbs. charges which had not been required for use were still in the box at the time of the explosion. These were also closed by the compressed india-rubber disc. It might be almost assumed, therefore, that the explosion which occurred was not that of one or more of the charges in the box, but of the 20 lbs. charge, which had failed to go off under water, and had been placed, as stated above, on one of the thwarts of the boat by Rennie. But the effect on two of the bodies, which were blown to pieces, places this beyond doubt, for the explosion must have been of the character known as a detonation, and the 20 lbs. charge was the only one which contained a detonator.

As the fuze had burnt through to the end, the explanation of the failure of this charge to explode when under water is doubtless either that when the fuze was somewhat roughly uncoiled, as noticed by Mr. Gaster, a pull or a jerk caused the detonator, which was not "nipped" to it, to become detached; or that the flash from the fuze failed to ignite the composition of the detonator, which was protected, as above stated, by tinfoil.

There appear to be only two possible causes which could have brought about the subsequent explosion of this charge in the boat. At the time of the explosion the men were returning in the boat to the site of the wreck, in order to satisfy themselves that the work of the day had been accomplished, as, indeed, they fully expected; no further charges in all probability would be required, but they had on board the boat a charge containing a detonator which could not well be taken on board the "Mermaid" or replaced in a magazine unless its fang, so to speak, were removed. The first possible cause is that Rennie, who was looked upon as an "expert" in blasting operations, and who had already, as we know, taken up the charge from the bottom of the boat and placed it on a thwart, was at the moment actually engaged in attempting to

remove the detonator. If it remained still embedded in the tonite, this would be an operation of some difficulty, and an explosion might have easily been brought about while he was trying to carry it out.* The other possible cause which may be assigned is that the 20 lbs. charge was knocked off the thwart by one of the men, and that the explosion of the detonator it contained was effected by its fall on to the bottom of the boat. This is, in my opinion, far the less probable of the two possible causes. I do not think that it can be reasonably believed that any smouldering fire from the fuze could have remained in the "gland" of the charge for a period of an hour, that time having elapsed since the fuze was first lighted, the fuze, moreover, having either been pulled out or cut off by Clavell half-an-hour previously. Instances have certainly been known of retardation in the burning of safety fuze extending to 20 minutes, or half-an-hour, but I am unable to meet with any instance of such a lengthened retardation as would have happened in this case.†

As to blame to be attached.

Whether, however, the explosion is rightly to be attributed to one or other of these two causes or not, there can be no doubt that Clavell, who paid the penalty for his disregard of his superior's orders by the loss of his life, was instrumental in bringing it about by the recovery of the charge. But he alone was not to blame in the matter. Indeed the successive steps leading up to the accident appear to have been all more or less blameworthy or open to criticism. In the first place, Mr. Gaster, over-estimating his knowledge of blasting operations, proposed that he should conduct the work himself, and incorrectly reported that he had all that was necessary for carrying it out; then the Trinity House, accepting his rating of his qualifications, authorised him to conduct it without being satisfied that he was competent to do so.‡ Again, Mr. Gaster, when he had received the order to undertake the work, and when he cannot have failed to have known that he had not the necessary appliances at his command, instead of pointing out to the Trinity House that the charges were adapted for firing by electricity, and he had no battery, and that, moreover, although he had safety fuze, he had no detonators if they were to be fired without a battery, proceeded illegally and at no small risk to himself and Clavell to obtain detonators by breaking up the electric detonator fuzes.§ Next comes Clavell's disregard of orders; and, lastly, Mr. Gaster, when informed of this disregard, took no exception to it, and, moreover, did not attempt to get rid of the dangerous charge, as he might have done, either by replacing it on the wreck and firing another charge in proximity to it or by throwing it overboard into deep water.

It is obvious that the direction of work of this kind should be entrusted only to properly trained operators. The fact that the Superintendents have been present at or taken part in previous dispersions is not, in my opinion, a sufficient qualification for their conducting one without a special training in the handling of the explosives and the preparation of the charges.

Copies of the reports by Dr. Dupré on the samples of safety fuze and electric detonator fuze, which I received from Mr. Gaster as similar to those used on the occasion, will be found in the Appendix. They were both of excellent quality.

Coroner's inquest.

Mr. E. M. Blake, Coroner for the Isle of Wight, held his inquest on the bodies of the deceased on the same day, viz., the 19th July. He failed to adjourn it as required by the Explosives Act.‖ The verdict of the jury was "That the deceased being on "board a boat on the Brambles were killed by a torpedo accidentally exploding in the "boat."

Illegal storage of explosives in lightships.

In the course of my Inquiry it came to light that the Trinity House have habitually stored the tonite used in these blasting operations in certain lightships without any

* There were no implements in the boat except a screw wrench for removing the nuts, but Clavell had a penknife for enlarging the holes in the india-rubber washers.

† Mr. Gaster could give no information as to what was going on in Clavell's boat at the time, as although he was standing up and looking in that direction, his attention was occupied by pieces of the wreck floating about his boat.

‡ I am informed by the Secretary of the Trinity House that since the passing of the Removal of Wrecks Act in 1877, 89 wrecks have been dispersed by means of explosives in the various districts without the aid of the diver up to the 31st March 1894, and that no accident has resulted from their use until that now under inquiry.

§ Section 105 of the Explosives Act provides that any person . . . . . breaking up or unmaking any explosive . . . . . shall be subject to the provisions of the Act as if he manufactured an explosive. The penalty for illegal manufacture is by sections 4 and 39 not exceeding 100*l.* a day. In inexperienced hands the breaking up of these electric detonators might easily result in a serious accident.

‖ Section 65 provides that when a coroner holds an inquest upon a body of a person whose death may have been caused by the explosion of any explosive, the coroner shall adjourn such inquest unless a Government inspector or some person on behalf of the Secretary of State is present to watch the proceedings.

license. This practice is not in accordance with the Explosives Act; and, moreover, it is undesirable, in my opinion, that lightships should be used for the storage of explosives. Properly constructed magazines or stores should be provided on shore at the various points where the explosive is likely to be required and be duly licensed under the Act.

I wish to add that I received every possible assistance from Mr. C. A. Kent, the Secretary of the Trinity House, and from Mr. Gaster, the Trinity Superintendent at Cowes, when holding the Inquiry, and to express my thanks to them for the same.

I have the honour to be,
Sir,
Your obedient Servant,
A. FORD,
Colonel,
H.M. Inspector of Explosives.

APPENDIX.

CHEMICAL EXAMINATION.

No. of Sample, 4,281. Date, July 28th, 1894.

Name of Material.—Safety Fuze.

From whom received and when.—Colonel Ford, R.A., July 27th, 1894.

General Result of Examination.—A piece of safety fuze, covered with a double layer of india-rubber.

Both as regards soundness of india-rubber, and rate of burning the fuze, was in perfect condition. Two white cotton threads in powder column.

Details of Sample and Examination.—Marked "Safety fuze, received from Mr. Gaster, at Cowes, " July 24th, 1894, A. F."

Piece of safety fuze, 18 inches long made up, counting from the powder column, which contained two white cotton threads.

(*a.*) Two layers of thread wound spirally round in opposite directions, the innermost layer of 10, the second of five to six threads.

(*b.*) A layer of india-rubber 0″·035 thick, put on without joint.

(*c.*) A layer of tape wound round spirally in the same direction, as the innermost layer of thread.

(*d.*) An outer layer of india-rubber 0″·022 thick, put on without joints, probably in the liquid condition; both india-rubber layers were sound.

Two pieces of 6 inches in length, burnt in—

1st piece	- - -	11 seconds.
2nd „	- - -	11 „

(Signed) A. DUPRÉ.

CHEMICAL EXAMINATION.

No. of Sample, 4,282. July 28th, 1894.

Name of Material.—Electric Detonator Fuze.

From whom received and when.—Colonel Ford, July 27th, 1894.

General Result of Examination.—Powerful low tension electric detonator fuze, containing 22·2 grains of a mixture of fulminate of mercury, chlorate of potassium, and guncotton.

Details of Sample and Examination.—Marked "Electric Detonator Fuze, received from Mr. Gaster, " at Cowes, July 24th, 1894, A. F."

Electric detonator fuze consisting of a large copper cap, 1·″35 long, 5/16″ outside diameter, with flat dome-shaped bottom. No mark. The open end was closed by a wooden plug, with large round flat-headed top, through which passed two small copper tubes connected to two wires, the ends of which passed into the detonator, where they were connected by a very thin wire embedded in a small quantity of an explosive composition, consisting of gunpowder and guncotton, placed on the top (but separated from it by tinfoil) of a mixture of fulminate of mercury, chlorate of potassium, and guncotton, which filled about half of the copper cap. Electric connexions perfect.

Weight of fulminate mixture, 22·2 grains.
Consisting of—

Guncotton - -	0·8	=	4·1 per cent.
Fulminate of mercury - -	16·3	=	73·9 „
Chlorate of potassium - -	5·1	=	22·9 „
	22·2		

(Signed) A. DUPRÉ.

FIRST REPORT

OF THE

COMMITTEE APPOINTED TO ENQUIRE INTO THE ACCIDENT OF THE 13TH DECEMBER, 1893, AT THE ROYAL GUNPOWDER FACTORY, WALTHAM ABBEY,

AND INTO

THE CONSTRUCTION, &c., OF THE DANGER-BUILDINGS AT WALTHAM ABBEY

AND

THE ROYAL ARSENAL, WOOLWICH,

TOGETHER WITH

MINUTES OF EVIDENCE AND APPENDICES.

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1894.

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NAMES OF MEMBERS OF THE COMMITTEE.

Chairman.

Lord SANDHURST, Parliamentary Under Secretary of State for War.

Members.

Sir FREDERICK ABEL, Bart, F.R.S., &c.

Colonel V. D. MAJENDIE, C.B., Her Majesty's Chief Inspector of Explosives.

Major-General F. T. LLOYD, C.B., R.A., Deputy Adjutant-General of Royal Artillery.

Mr. R. H. BRADE, *Secretary.*

REFERENCE.

Copy of terms of reference to the Committee appointed to conduct the enquiry into the recent explosion at the Royal Gunpowder Factory, Waltham— 74 Gen. No. 3626

(1.) To enquire into the cause of the accident.

(2.) To suggest any means which they consider should be adopted to ensure safety.

(3.) To report on the construction of the danger buildings throughout the Royal Gunpowder Factory, and to recommend any alterations required for greater safety to surrounding buildings in case of fire or explosion.

(4.) To extend the enquiry as to (3) to the Royal Arsenal, especially with reference to the factories which now surround the danger buildings and to the locomotive traffic around them.

Approved by the Secretary of State on 16th January, 1894.

Enquiry into the Accident of 13th December, 1893, at the Royal Gunpowder Factory, Waltham Abbey.

FIRST REPORT.

Secretary of State,

The terms of the reference to the Committee appointed by you on 16th January, 1894, in consequence of the accident which occurred at the Royal Gunpowder Factory, Waltham Abbey, on the morning of the 13th December last, are as follows:— Reference.

1. To enquire into the cause of the accident.

2. To suggest any means which they consider should be adopted to ensure safety.

3. To report on the construction of the danger buildings throughout the Royal Gunpowder Factory, and to recommend any alteration required for greater safety to surrounding buildings in case of fire or explosion.

4. To extend the enquiry as to 3 to the Royal Arsenal, especially with reference to the factories which now surround the danger buildings and to the locomotive traffic around them.

Your Committee observe that the enquiry entrusted to them by this reference is twofold:—(*a*) The one portion bears upon the circumstances and cause of the recent accident, and the means to be suggested to prevent a recurrence of a similar accident, and (*b*) the other portion, of a more comprehensive scope, relates to the condition and regulation of all danger buildings belonging to the Ordnance Factories at Waltham and Woolwich. They have accordingly conducted their proceedings with the view to be in a position to report to you separately on these two divisions, and, considering (*a*) to be the more pressing, they have taken at once all the available evidence necessary, in their opinion, to the elucidation of this branch of the enquiry, and they beg to now lay before you their report thereon.

The Committee, as a first step, visited the Royal Gunpowder Factory and inspected the scene of the accident. They afterwards held meetings at the War Office, and have examined the Superintendent and other members of the staff of the factory, besides a number of men employed in the class of work which was being carried on in the building destroyed, including the only man who succeeded in escaping without injury. They also examined Colonel A. Ford, one of Her Majesty's Inspectors of Explosives. Proceedings of the Committee.

I.—Circumstances of the Accident.

The accident took place at 2.35 a.m., on the 13th December, 1893, at No. 2 cam house, situated on the portion of the factory grounds at Waltham Abbey, called the Lower Island. The weather was stormy, a strong wind blowing, and rain falling heavily, but there was no lightning. The scene of the accident was a building which appears to have been erected in 1846 or 1847, and was used as an incorporating mill until 1887, when it was converted into a cam house. It was made entirely of wood, with the exception of a brick wall at the south end, and the roof was boarded over, fastened with iron screws, and covered with tarred felt. At the time of its conversion the building, including the roof, was lined throughout with varnished match boarding, and the floor was covered with hides, all fastenings being effected with copper nails. Scene of the accident and description of building.

11, 845, 1202
240-1, 503–4
Appendix I.
507, 515
244, 505, 508–9

Another alteration made at the time of the conversion was the elevation of the floor of the house to accommodate the cam-machines. This caused a difference of 9 or 10 inches in the levels of the floor and the outside platforms, and, in fact, at each entrance there was a well or recess caused by this difference of level. The building was lighted by electricity, the lights being outside the windows and the wires carried on earthenware insulators. It was provided with a lightning conductor and was heated by hot-water pipes. 253 168, 1489 510, 697 417

A water-wheel, enclosed in a compartment between the two portions of the house in which the machines were placed, supplied the motive power. The sides of this compartment were of wood, and there was no opening in the partitions except to the extent of $\frac{1}{16}$th of an inch round the shaft connecting the wheel with the machines. The wheel was worked by the fall of water from a stream (the head stream), which ran on one side of the building into another stream (the tail stream), at a lower level, on the other side. 247-54

The two divisions of the house were connected by a covered wooden corridor, from each end of which an open platform reached down to the edge of the head stream. Both corridor and platforms were of the same construction as the house, but the floors were not covered with leather. The boards forming them were laid with openings of about $\frac{1}{8}$th of an inch between them, and were constantly kept wet. 541 542–3 557, 629, 1407

The corridor and platforms were lighted by one electric lamp, which was placed in the centre of the corridor opposite the wheel. 267

Each portion of the house was provided with a door in each corner opening outwards, and fastened by a rope and counterweight. 632-4

The door in the south-east corner of the south end opened into a small room where the workmen put on their "clean" shoes. This room was of wood, with the exception of the roof, which was of slate, and of the one side which was formed by the brick wall running the length of the south end of the building. 1881

With the exception of parts of the shoe room, and the dirty mats at the doors on the west side, the whole building was "clean." The shoe room was mainly dirty, but contained "clean" islands, so to speak, in the form of small wooden moveable platforms, or stools, on to which men stepped from the house when going temporarily into the shoe room, thus avoiding the removal of their "clean" shoes. The mat in this room is stated by the master worker to have been "dirty," though the men seem to have regarded it as "clean." The covered boats which conveyed the grain powder to the buildings and removed the finished prisms, also are "clean" with the exception of a small compartment answering the same purpose as the shoe room in the house. 1535 1535-7 1748, 268-9

Nature of work carried on in No. 2 cam house.

The operation in progress at the building at the time of the accident was the pressing of grain powder (E.X.E.) into prisms by means of cam-machines. Two views of one of these machines, together with a description of their construction, are given in Appendix II. Briefly, the machines are provided with an upper and a lower set of plungers, which move vertically to and from each other, each pair meeting in a receptacle or channel in a fixed table called the bush-block, the receptacle being called the matrix or "bouche" (bush). The grain powder is carried forward and dropped into the bushes by a carrier or charger, which is itself fed from a hopper, and the powder is compressed into prisms by the approach to each other of the two plungers. Appendix II.

The charger moves backwards and forwards horizontally, and, besides serving to carry the charges from the hopper to the bushes, pushes forward the prisms as they emerge from the bushes after having been pressed. The lower plungers contain pins or drills, which pass upward into holes in the upper plungers as the two sets approach each other. The machine works automatically by means of eccentrics or cams.

The four machines in No. 2 cam house pressed in succession, there being in each end of the house a "tell-tale" showing the working of the machines in the other end. The machines were worked so as each to complete four pressings a minute. 783-4 343

The hopper is filled with powder from a barrel which stands behind each machine, a copper bowl being used for the purpose. The powder is brought to the house in open barrels, covered with pieces of sacking, by the covered 376, 1619 37, 485-6

boats already referred to, along the head stream to the platform which leads down to it. The barrel is lifted from the boat on to the platform, trundled on
1254-61 its chine along the platforms to the house, where it is again lifted up the step on to the floor, and then finally trundled to a position behind the machine. At Waltham each machine is looked after by two men, one of whom stands behind
343-4, 1783 the hopper; his duty is to fill it and to work the lever which stops the machine, while the other, who stands in front of the machine, watches the working of the charger and plungers, and puts on to a rack the prisms as they are pushed off. At No. 2 cam house these men were subject to the supervision
53 of a foreman, who, in addition to this duty, gauged the prisms on the racks and determined the density of a proportion of them.

Occupation, &c., of men at the time of the accident.

At the time of the accident the machines were all at work, and a boat was alongside from which the two boatmen were supplying the house with powder.

There were thus in or at the building eleven men, *i.e.*, two workmen to each of the four machines, the foreman, and the two boatmen.

The work hours of the night shift were from 6 p.m. to 6 a.m., but on this occasion the men came on an hour earlier, and would have left off an hour later, in order to make up time to enable them to take a holiday on Boxing
50 Day, which is not a Government holiday. They had worked continuously with
706, 718 the usual interval for a meal at 11 o'clock. They were all dressed, according to
750, 1008 the regulations, in a suit of lasting cloth over a suit of private clothing kept in the factory.

The evidence of Skinner, the one man who escaped uninjured, and the
490 statements which some of the other men made before their death to Mr. Findlay, the master worker, show the succession of events immediately connected with
Appendix I. the accident. Reference to the plan given in Appendix I. will further illustrate what the Committee here give as their version of the events, and will show the approximate position of each man at the time of the explosion. The position assigned on the plan to the boatman Watts will be explained later.

Skinner was in the north end of the house, in front of No. 5 machine. He
720-2 heard a report in the other end of the house "like a 7-pr." He also saw
723, 891, 897 a flash through the door opening into the corridor at the south-east end of his compartment, which was more or less facing him. He at once turned to the
723-4 door behind him, and, before he got out, heard a second explosion. He had only reached the trees a few yards from the house when "the whole thing
725 seemed to go at once; I heard, however, no more than a rumbling noise, because I was so near it." This account is corroborated by the statement of
790 the foreman Bailey, who was close to Skinner at the time, and who speaks of
490 hearing a rumbling noise which excited the attention of the men in the north end of the house, followed by another noise accompanied by a flash, whereupon all the men started to run out of the house; and he adds "I had got clear of the house before it exploded, but appeared to have been blown in the water
Appendix VII. while running away." Two men (Biss and A. Carr) working at the drum house 100 yards away also heard three reports, the second occurring while they were changing their boots, which they proceeded to do immediately on hearing the first, and they heard the third after they had run nearly the distance between the drum- and cam-houses.

Of the men in the south end of the house, Rudd and Rudkin could only
1610-11 say that they saw a flash and nothing more; they got clear of the house and into
Appendix VII. and 490 the river (*i.e.*, the head stream), out of which they were helped, the former by
490, Appendix VII. Hare and the latter by A. Carr and Biss. Clayden saw a flash come, as he says,
1572 from his machine as he was turning away from it towards the north to put prisms on the rack beside him; and Larman, who was similarly engaged, says the same, adding that "when the explosion took place Clayden and myself ran out
490, Appendix VII of the house and got into the river," *i.e.*, the tail stream, "where we were found" by A. Carr and Biss. Watts alone of all the men did not get out of the house, and must have been killed almost immediately. Lastly, Hare, the second boatman, who was apparently on or by the boat, says "the first flash was seen" (presumably he means by himself) "coming from the south end. I went to the
490 door of the boat and took off my "clean" slippers, when I was knocked in the river."

According to all the evidence Watts must have been in the south end of the house at the time of the accident. Bailey, going from the south to the

north end, met him wheeling a barrel towards the former, just opposite the water-wheel, and had time to walk to the north side of No. 5 machine before the first report was noticed. Allowing a little extra time for the work that Watts was doing, including the lifting of the barrel up the step, he must have about reached the spot indicated on the plan at the time when Bailey reached No. 5 machine and heard the first report, and this was the spot where his body was found by the fireman Jackson. It seems clear that Watts was rendered unconscious, if not killed on the spot, immediately on, and perhaps by, the first or second explosion. 490 790 Appendix I. 1124 1180

Character of accident.

From the evidence given it appears that the character of the accident was more that of a fierce fire than of an explosion. Watts showed signs of explosive injury, and Bailey speaks of being "blown into the river," while Hare says he was "knocked into the river." Reports were heard at the drum house, 100 yards away; and it is also said that a report was heard up at the Superintendent's house. On the other hand, the nature of the injuries of the men, excepting Watts, and the damage to the structure—both of which will be referred to in detail later,—as well as the character of the explosive material, point rather to a fire than to an explosion. At any rate there was no violent explosion, for the trees near were not affected, nor were windows broken in a building distant 34 yards. The fireman, who lives 5 minutes' walk away, heard no report until after the fire had been burning 20 minutes; and the water tanks over the mills across the stream were not capsized, though they are so balanced as to be liable to disturbance by the shock of an explosion. Appendix VII. and 32. 10 277-81 533 1175, 1178, 1198 1198

The amount of powder which exploded or burnt was about 1,200 lb. The quantity missing after the accident was found to be 12 barrels, each being calculated to hold 100 lb.; but they were never actually full by a few pounds, and the exact amount is therefore nearer 12 times 90 lb., or 1,080 lb. Of this the greater part is stated to have been in the form of prisms, *i.e.*, 8 barrels in this form and 4 full of grain, as the boatmen had cleared the house of prisms, and had already taken two barrels of grain into the north end, *i.e.*, one to each machine, while Watts was taking a third barrel into the south end, and a fourth still remained in the boat. There would probably have been some grain in the hoppers, but beyond this small quantity and the four barrels the rest would have been in the form of prisms. 284-5 286 490

II.—Results of the Accident.

A.—*Injury to Men.*

As has been stated, there were 11 men in or immediately about the building; five were in the north end, five in the south end, and one at the boat.

Of those in the north end, one, Skinner, escaped uninjured; another, Carr, working opposite him at the same machine got away with his clothes on fire, and although Skinner threw water over him he was badly burnt and has been in hospital since then until about the 7th March. He has, however, recovered. Bailey, as has been already stated, got out of the house but was blown or fell into the water (the tail stream), where he remained for nearly an hour, until he was rescued by the fireman Jackson and a man named Brown. He appears not to have been much burned, but mortification set in; he died on the 19th December at 12.45. Jennings got away into the head stream, but his escape was delayed by his having tripped over the shafting in making for the door opposite to him instead of the one behind him. He also thus met the force of the explosion from the boat, but was not so much injured but that, after having been helped out of the stream by Hare, he could walk up to the shifting room. He died, however, the next day. Massey got away and was assisted by Skinner, but died the same day. 727 490 1179, 1224 1225-6 490 1612 490, Appendix VI. 727, Appendix VI.

Of the men in the south end, Clayden and Larman ran out of the house by the doors behind them, and got into the tail stream, whence they were pulled out by Biss and A. Carr. They were badly burned, but conscious, and each made a statement about the accident; the former died the next day, and the latter on the 18th December. Rudd and Rudkin escaped by one or other of the two doors behind them, and got into the head stream. The former was Appendix VII.

490 helped out by Hare, and walked with him to the shifting room. He was very severely burned, and died the next day. The latter was rescued by Biss and Appendices VI. and VII. A. Carr, and died the next day. Watts did not escape; his body was found 1181, 1185 by Jackson, after a minute search, lying on the face, with the head to the 1124, 1184 north, about 2 or 3 feet from the machines. The body had fallen, apparently, 1184 through the burning floor into a brick trench, and was very much burnt. "Part of the left side of his head was blown off, and his arms and feet and part 1115, 1183 of his trunk were burned away." Subsequently one of his hands was found in a spot between the north end of the house and the head stream; it was not 1188-90 burned but had been blown off. Lastly, Hare was knocked from the boat into the river, but was able to get out and rescue Jennings and Rudd, and walk up to the 490 shifting room; he died on the 19th December.

Thus of the 11 men only one escaped uninjured, and only one has recovered from his injuries.

B.— *Structural Damage.*

1. The building being mainly of wood caught light readily, and was blazing 1174-7 freely within 10 minutes of the first explosion; 20 minutes later there was a 459, 553, 1178 slight explosion, but with the exception of the windows of the building there appears to have been no damage due to explosion. The roof remained on and Appendix VI. the walls standing. The fire did not, however, burn itself out; it was extinguished 529, 1233 by the firemen, but the house has been so damaged that it has had to be pulled down. The tarred felt roof blazed, and its liability to be blown about in the high 11, 535 wind constituted an additional danger, which, however, the fireman successfully 1218 met. The only sound part of the structure remaining is the brick wall at the 527-8 south end, which is not even cracked.

251, 1222 2. The water-wheel continued to revolve until the roof fell in and a beam jammed it.

423, 1222 3. The machines also went on working for some time after the house took fire. A screw, doubtless from outside the inner roof fell into one of the bushes 442 513-18, 1720 in No. 2 machine, the plunger of which bush was afterward found to be broken; otherwise all the machines were in good working order after the accident, 1667, 1717 except of course for the dirt which in the progress of the fire, &c., got into them.

287, 1197 4. Lastly, the boat has been rendered useless; the hood was blown off, and there is a leakage at one side.

III.—Probable Cause of the Accident.

In considering accidents of this sort, it is often possible to be guided to the probable cause by some decided indication as to the point of origin.

In the present case, unfortunately, the indications are to some extent contradictory. The Committee are able to say positively that the first explo- 720 sion occurred in the south compartment, but beyond this they are unable to go with any confidence. The only available direct evidence would seem rather 490 to indicate No. 2 machine as the point of origin, the statement, namely, made by Clayden before his death to the effect that a flash came from his (No. 2) machine; but, on the other hand, it may be urged that a flash pro- 1568-72 ceeding from any part of the house situated in the direction, relatively to Clayden, that his machine occupied, might easily appear to him to have proceeded from, *i.e.*, to have originated at, the machine itself. There is, indeed, 282, 490, 1180 some ground for considering the barrel of E.X.E. powder which Watts was rolling in, at the time, as the probable spot where the explosion originated; 682, 1182, 1187-8 for, on the one hand, Watts alone, of all the injured men, had undoubtedly sustained injuries due to an explosion (as distinguished from mere burning), and the experiment recently carried out at Woolwich, and described in Appendix XV., has demonstrated that the ignition of a barrel of the E.X.E. powder is attended with very marked explosive effects. On the other hand, there seems no *prima facie* reason why, if the explosion originated at one of the machines, Watts should not have been able to get as far away from the effects

as, at any rate, Rudkin and Rudd did, whose position some of the witnesses and the plan indicated as having been nearer to the machine, and further from the doors, than Watts. As a matter of fact, Watts was killed, and his remains, as already stated, showed evidence of explosive violence; while Rudkin and Rudd were not explosively injured; although severely burnt, they both effected their escape from the building, and did not die until the following day, 14th December. It is conceivable, of course, that Watts may have been stupefied or knocked down by the first explosion, and that he lay in the vicinity of the barrel when it exploded, and received from its explosion further injuries, whereas Rudkin and Rudd were able to get out before the barrel exploded; indeed, the two last-named men may have been sitting, as one witness suggested, on the seats on either side of Watts, being thus actually nearer the doors.

Appendix I. 473, 1782

Biss's statement in Appendix VII. 490, 1232, 1585, Appendix VI.

1586-91, but see also 1777-83.

It is also significant that in the experiment at Woolwich, when the E.X.E. powder in the barrel was lighted at the top, it produced no fracture of the platform, or crater, or other damage; while, when the powder was ignited at the bottom, a sensible increase of violence of explosion occurred, which determined the fracture of the platform. This result would seem to indicate that if the accident had originated, say, by friction of the barrel on the floor, there would have been a more violent explosion, and more marked effects than were actually experienced; whereas, if the barrel had been fired by a burning prism projected on to the powder, the results would have been probably more closely in accord with those which were observed.

Appendix XV.

The Committee are thus really without anything to guide them positively as to the initial point of the explosion; they know that it occurred in the south end, but whereabouts in the south end the evidence leaves them in doubt.

Examination of various possible causes.

The Committee are, therefore, driven to approach the examination of the question from another direction, and to adopt the course which has before been usefully followed in enquiries into accidents of this character, and when the origin of the disaster is not immediately apparent, viz., that of setting forth the various possible causes which might operate to bring about such an explosion, and then, by a process of elimination, disposing of those causes which could not be connected, however remotely, with the case immediately under consideration. In Appendix XVI., will be found a list, which the Committee believe may be regarded as fairly inclusive of all possible sources whence accidents in the manufacture of gunpowder could proceed. An attentive examination of this list shows that in the present case a very large proportion of these possible causes may be confidently dismissed. An examination of the evidence which the Committee have received appears to justify the conclusion that the actual causes of the accident may be sought among the following:—

Appendix XVI.

1. Defective working of machine.
2. Use or fall of tool or implement.
3. Lucifer match.
4. Presence of grit or other foreign substance.

1. *Defective Working of Machine*

With regard to this as a possible cause, the Committee may say at once that this is generally acknowledged as a risk.

Appendix XI. contains the substance of the replies received from gunpowder makers in the United Kingdom as to the results of their experience with cam-machines, and their testimony can hardly be regarded as, on the whole, favourable to these machines. It will be observed that in some cases they are stoutly condemned, while in another case, where the experience has been favourable, considerable stress is laid on the importance of keeping them at all times in thoroughly good order, a qualification which obviously suggests the existence of risk under particular conditions. The evidence given in the same appendix as to the behaviour of these presses in Germany shows, too, that under particular conditions their use may be attended with active risk.

Appendix XI.

The experience of one important English firm, derived from an experimental trial of these machines was so unfavourable that at considerable pecuniary loss they abandoned their use, and it will be observed that the particular defects signalized, were the "continual jamming and breaking of the plungers and pins," defects which it is abundantly clear from the evidence had occurred over

353, 1096, and the evidence of the mechanic, Mr. Johnson (1636-1724).

and over again with the Waltham Abbey presses. That the breaking of plungers constitutes no imaginary risk is clearly shown by what occurred at Messrs. John Hall & Sons cartridge factory at Nottingham, in 1880 and 1881, when two accidents occurred, one (in 1880) fortunately unattended with serious consequences, the other (in 1881) resulting in the loss of three lives. The circumstances of these accidents are fully detailed in a special report by one of Her Majesty's Inspectors of Explosives. It will be sufficient to say that the first, certainly, and the second, beyond reasonable doubt, were caused by the chipping of metal from what the Committee understand to have been bronze plungers.

Special report, No. XXXII., dated 9th March, 1891.

Indeed, it must be evident to anyone familiar with the subject, that the fracture of a plunger is a contingency which in no circumstances should be regarded with equanimity—as in fact it had got to be regarded at Waltham Abbey. Nor should the circumstance that plungers have frequently broken in the Waltham Abbey presses without causing an explosion, remove the anxiety which such a defect undoubtedly justifies, as that circumstance goes no further than showing that the exact conditions necessary to produce an explosion were not present in those cases. It is noticeable that at the Eastwood Factory above mentioned, "chipping" of the plungers had occurred, not infrequently, before such an occurrence actually gave rise to the explosions of 1880 and 1881. Indeed, it is probably within the experience of all powder makers that things may and do happen without explosion or other serious result, which under other circumstances might be expected most certainly to produce them.

The Committee have no hesitation in expressing their opinion that if the breaking of the plungers and the bending of the pins to which several witnesses have borne testimony, cannot be guarded against, machines known to be liable to such defects should not be worked; and if the evidence of Mr. Johnson, the mechanic, is to be accepted as conclusive, those contingencies cannot be guarded against.

1677-80

When, however, they come to consider the question of whether it is probable that this particular accident was due to such a cause, the Committee are disposed to dismiss the hypothesis, for the very sufficient reason, as it appears to them, that it was positively asserted in evidence that, after the explosion, the machines were (with an exception to be presently mentioned, and making allowance for the dirt and débris arising from the explosion) in a condition in which, with the application of a little water, they might have been at once set to work. The exception was a screw which had got into a bush of No. 2 machine, the plunger of which bush was found to be jammed down and broken; but the Committee were able to satisfy themselves that the entrance of this screw into the machine had undoubtedly succeeded, not preceded, the explosion. The screw was identified as being of the same kind as others which were found on the floor after the fire, having evidently fallen out of some part of the roof of the building exterior to the wood lining; it was, therefore, not possible of access to the interior until the lining had been more or less destroyed or opened by explosion or fire, or otherwise. It is most probable that the presence of this screw in the bush, while the machines continued to work after the explosion, caused the jamming and the breaking of the plunger. It would at any rate have been a most extraordinary coincidence that the only screw (or foreign body) which fell into a bush after the accident should have fallen into the particular bush which had a broken plunger. So far as the Committee have been able to gather, the machines, with their plungers and pins, were in proper working order at the time of the accident.

131, 423, 1222

1667, 1717

422-4

513-17

426, 513-17, 1718-23

783-7, 1717

Probably the evidence as to the generally efficient condition of the machines after the accident may be accepted as fairly conclusive that the explosion was not the result of their having become clogged. Such a defect, if of a serious character, could hardly have failed to be apparent after the event, and must have continued to impair the efficient working of the machines.

The Committee had some evidence as to the heating of the pins, and it was suggested that this heating might be dangerous. The Committee do not share this view. None of the evidence was conclusive as to the pins or any of the working parts having become heated to a temperature above that at which the naked hand could be borne on them, or something considerably under 212 degrees Fahrenheit, while gunpowder cannot be fired under about 540 degrees Fahrenheit.

Appendix VII.

1331-5, 1525-7

2. *Use or fall of Tool or Implement.*

There was ample evidence before the Committee that at least three steel tools, or so-called spanners, were present in the building, and that the workmen had access to them and were in the habit of using them; and although the Committee have no evidence before them that the accident was caused by the fall of one of those spanners, it is proper to remark that accidents have occurred in this way, and that the presence of these implements in the house constituted a risk which might have given rise to such an accident as that under notice. Appendix VIII. contains a list of several accidents caused by tools and implements, and among them is one which occurred in March, 1872, at Messrs. Bickford, Smith & Co.'s fuze factory at Tuckingmill, Cornwall, which strikingly illustrates the risk to which the fall of a steel tool in a building containing gunpowder may give rise. On that occasion eight girls lost their lives. The accident at Factory 15, in 1878, as described in that Appendix, is also instructive.

362, 803-4, 1297, 1514, 1659-60, 1845-7 Appendix III. Appendix VIII.

But the evidence also points unmistakeably to the existence of a practice which experience shows is attended with risk—the practice (namely) of effecting alterations or adjustments in, or quasi-repairs to, the machines while powder was present in the house; and even it must, we fear, be believed while powder was present in the machine itself, and certainly without the machine having been previously washed out. In the judgment of the Committee, such a practice—indeed any adjustment or repair or alteration of a machine by anyone, except a competent mechanic, and then only when all powder has been removed and the house and machine have been washed out, is open to the gravest objection. Evidence has been laid before the Committee by the Department of Her Majesty's Inspectors of Explosives that numerous accidents have been due to this cause, of which an instructive list is given in Appendices VIII. and X. Among them the accidents at Factory 29, in 1883; Factory 19, in 1886; Factory 23, in 1887; Factory 2, in 1890; Factory 20, in 1891; and Factory 15, in 1893, merit particular attention. And the language of the Explosives Act, 1875, is extremely emphatic on this point. Section 10 (5) lays down: "Before repairs are done to or in any room or other part of a danger building, that room or part shall, so far as practicable, be cleaned by the removal of all gunpowder, and wholly or partly mixed ingredients thereof, and the thorough washing out of such room or part; and such room or part of the building, after being so cleaned, shall not be deemed to be a danger building within the meaning of these rules until gunpowder or the wholly or partly mixed ingredients thereof are again taken into it." It will be seen from Colonel Ford's evidence that Her Majesty's Inspectors of Explosives attach very great importance to the strict observance of this regulation, and in the opinion of the Committee it is one of such paramount importance that the widest possible meaning should be assigned to the word "repairs," so as to include any adjustment or alteration of a machine necessary to its more efficient working.

373-5, 1000, 1085-8, 1095, 1098-1100, 1690-1700 770-82, 1306-7 Appendices VIII. and X. 1972-5

3. *Lucifer Match.*

In cases of this sort the possible presence of a lucifer match must always be a matter inviting suspicion and investigation, and such suspicion can only be disarmed by evidence tending to show that the precautions adopted at the factory are of such a character as to render the presence of a match almost a physical impossibility. It might, at first sight, be supposed that the well-known and certain danger to which the presence of matches in a gunpowder factory gives rise, would be a sufficient guarantee that men who valued their lives would most readily co-operate to ensure their rigorous exclusion. Unfortunately, experience is all the other way. Her Majesty's Inspectors of Explosives (as we learn from Her Majesty's Chief Inspector, himself a member of this Committee) have on *several* occasions found workmen with matches in their possession in danger buildings. Probably every gunpowder maker in the kingdom could furnish testimony to a similar effect; and one such case occurred at the Roslyn Gunpowder Factory so recently as the 24th October, 1891, when a match was discovered in the drying-house,* and at a time when, owing to the

* *See* Annual Report of Her Majesty's Inspectors of Explosives, 1891, page 30.

fact that only the year previously no less than eight lives were lost by two explosions in this factory, it might reasonably have been supposed that the workpeople would have been specially alive to the value of precautions adopted for their safety. Three cases of the discovery of matches, suspected to have been maliciously introduced, at Messrs. Curtis's & Harvey's Hounslow factories, in the autumn of 1886, are referred to in the Special Report on the serious accident which occurred at that factory in the following spring.* Also matches (as the
1787-8 Committee learn from the evidence) have been found in the past in the danger buildings at Waltham Abbey. Experience in mines is probably even more striking. Over and over again have accidents (often of a most dangerous character) been traced to men smoking, or striking a match, or opening their safety lamps.

In short, if one thing is more clearly established by experience than another it is, that precautions, even of the most obviously necessary character, cannot be depended on to be adopted or observed by the workpeople themselves, but must be enforced by some special device or regulation.

The Explosives Act, 1875, directs that in regard to the exclusion of matches this is to be effected by the "use of suitable working clothes without pockets . . . . . searching, and otherwise, or by some of such means," (Section 10 (8)); and no pains are spared by Her Majesty's Inspectors of
1959-60 Explosives to secure the full observance of this regulation in private factories. The General Rule above referred to, which is required to be posted in every danger building, itself operates in this direction, while the particular method (whether by "working clothes without pockets, searching, or otherwise") to be observed is distinctly defined, either by the licence or by the Special Rules. Moreover, in the best regulated factories a responsible person is required to sign a daily report or book to the effect that the workpersons' clothing has been properly searched (female searchers being appointed where women are employed), while Her Majesty's Inspectors of Explosives themselves at their visits (which are always unexpected) personally search a very large majority of the workpeople and see that their clothing is free from pockets; but even these cumulative precautions have not always sufficed to secure the exclusion of matches.

The evidence before the Committee goes to show that the precautions adopted at Waltham in regard to this important point fell very far short of those which have been found necessary, and by no means excessive, at private factories. Indeed, the evidence has clearly established that great laxity has prevailed in this direction.

Apparently it has been hitherto deemed sufficient to rely upon the following precautions to exclude matches or other dangerous articles:—

1. A search by the police at the gate.

2. A change of clothing in the dressing room.

3. An inspection, by the foreman of each house, of the men under his charge.

The Committee are not prepared to say that if these precautions were invariably enforced to their full extent they would not reasonably suffice; but the evidence shows that they were very far from being applied in a strict or efficient manner; and it further appears that those who are responsible for the discipline and safety of the factory were under an entire misapprehension in regard to the manner in which one at least of these precautions was carried out.

Taking first the search at the gate; it appears from the evidence of the
930 Inspector of Police that, speaking roughly, only about one-tenth of the workpeople on entering are searched daily, and on eight occasions in a period of
Appendix IV. only seven months (from 25th June, 1893, to 25th January, 1894) men were found with matches. It is not an unreasonable inference that among the remaining nine-tenths unsearched were several, it might perhaps be suggested a similar proportion to those discovered, who passed with matches undiscovered.

Search by the police at the gates.

* *See* Special Report, No. LXXVIII., 31st May, 1887, pages 14 and 15.

It certainly would, in the judgment of the Committee, be a highly unreasonable assumption to believe that the eight men out of the one-tenth searched were the only men in the whole number employed who had matches, and, indeed, it is in evidence that in some cases matches have recently been found in the factory. It is proper to ask what became of those matches which there can be no doubt must have passed in. On this point the Committee will have to remark further on. 91, 407, 1542

It is also somewhat significant that of the eight cases of discovered matches no less than five occurred since the accident now under notice. The Chief Inspector of Police explains this by the fact that these were new hands, not so well acquainted with the regulations, or so habituated to leaving matches behind, as other and older employés. But on the other hand it might reasonably have been expected that the disaster of the 13th December would have brought home to the minds of all, whether old or new hands, the importance of precautions of this character, and the Committee feel constrained to remark that, in their judgment, the circumstance of these discoveries since the accident does reasonably suggest that the stringency of the inspection may have been less before than it has been since the accident. 983, 72

Indeed, the reply of the Inspector of Police to two of the questions appears to distinctly point to considerable inefficiency in the system of searching. He said, "The police do not actually put their hands into the men's pockets." "Do you make them turn out their pockets?—No, a man is liable to be searched by his foreman after entering the factory." Accordingly, the so-called searching in many cases obviously amounts to little more than passing the hand down the outside of the clothing, which would be unlikely to ensure the discovery of a single match, or to an enquiry of the man whether he has matches about him, and seeing that the penalty is dismissal, it is not difficult to anticipate the answer in such cases. Indeed, it must be a matter of surprise that, under such a system, any matches, except perhaps when a man had a box full, have ever been discovered at all. But further, it appears that the contractors' men, on the barges and elsewhere, who enter the factory, are never searched at all; although these men are by no means confined to their barges or vehicles while in the works. It seems therefore abundantly clear that so far as the search at the gates goes it can be of little avail to secure the exclusion of matches. 953-4, 940-52, 1851-3

Search in the shifting-house

But the danger-building men pass into a shifting room, where they have to change their over- and under-clothing, and put on clothes without pockets, or with the pockets sewn up, and without metal buttons or buckles, and, in the case of the oversuit, uninflammable.* A man is present, day and night, in this room, to see that these instructions are carried out. But it is obvious that it is impossible for one man to see that every one of a large number of men, amounting, it was stated to the Committee, sometimes to 200, conforms in all particulars to the regulations, especially in regard to such a detail as the absence, or effective sewing up, of pockets. And as the shifting-room man is under no obligation to make a report, or to sign a book or otherwise certify to the discharge of his duty, it is not difficult to understand that his examination of the men's clothing would readily become of a more or less perfunctory and easy character, in view especially of the physical impossibility of its effective discharge. 880-3, 1370

And this brings the Committee to enquire how it comes that if these shifting-house men properly discharge their duty, no matches have ever in a single instance been found by them. If, as has been shown, out of a proportion of one-tenth of the number of men, eight cases of the discovery of matches have occurred within a few months, while we know that in other instances matches have certainly found their way into the factory, what, it must be asked, became of the other matches, which no reasonable person can doubt must at one time or another have been brought by the unsearched nine-tenths into the factory? No evidence was tendered to the Committee to show that on any single occasion matches had been found by the searchers in the shifting room, and this circumstance appears to the Committee conclusive as to the 91

* The oversuit is provided by the Government, the under-clothing by the men themselves.

futility of the search, at that point, to ensure the non-introduction of matches; while it suggests also the comparative futility of this part of the system for ensuring the non-use of pockets, &c.

But a third line of defence existed, or was supposed to exist, against the introduction of matches, and that was the search of the men by the foremen at their respective houses. Apparently this was largely relied on by the staff at the factory, and the evidence given by those who are responsible for management and discipline, was to the effect that in their belief this duty was daily and rigorously discharged. In the course of the enquiry this view was completely upset, for one of the foremen employed (alternately with the foreman who was killed) in the cam house made the following reply to a question, "*We did not trouble much about it*" (*i.e.*, the searching) "*on night duty;* we generally did the searching in the day time, every Monday morning, and as we took turn and turn about for day or night duty, *that made the searching only once a fortnight.*"

Search by the foreman of the danger-building.

59, 88-9, 383, 397-8, 478, 1857-9, 1502

This entirely disposes of the efficiency of this part of the supposed protective system, and if that were not so it certainly is completely disposed of by the admission of another foreman, that it would be quite open to a workman to go back to the shifting room, say during the meal hour, and, if he felt cold, to put on a waistcoat or some other article of underclothing.

1140-8

Whether the boatmen were searched at all, or if so, by what official, was not made clear to the Committee. It further appears that no proper report was required of the foreman, scarcely a verbal report, certainly not a written one, that he had discharged the duty of searching the men. The master millman's duty was to go round at night (a duty only occasionally as it appears, discharged very late in the night), and he put his head in at the different doors and asked if all was correct, and if the foreman replied "Yes," he was satisfied. Much the same sort of thing occurred during the day shifts, the visits being then made by some representative of the master worker.

1759-67, 1033, 962-4, 1064-70

But one of three things is clear. Either the foreman who stated to the Committee that inspections were made only about once a fortnight, entirely misunderstood his duty as regards the searching, or he had, let us say, a different conception of it from that entertained by the managing staff of the factory, or he reported falsely on every occasion except the one day a fortnight when he had made his search. Indeed, if this foreman's evidence be correct ("we did not trouble much about it" (the searching) "on night duty"), it would appear that on no occasion of night duty could his report have been put forward as inclusive of searching, though according to the managing staff it was understood so to be. It should be added that the Superintendent was unable to refer the Committee to any written rule or regulation requiring daily searching. Obviously, therefore, and without pursuing this branch of the subject to greater length, it is clear that the whole system of search designed to secure the exclusion, was very weak and ineffective; and although the Committee are not in a position to say that the accident of the 13th December was due to the presence of a match, they feel it their duty to express their decided opinion that under such a condition of things as has prevailed at Waltham Abbey, it was quite possible for an accident to have resulted from such a cause. Indeed, it will be seen from the Superintendent's evidence that he is himself inclined to refer the accident under discussion to that, as the most probable cause.

1857-9, 1764-6, 1857-9, 1860, Appendix VI. 1900-4

4. *Presence of Grit or other Foreign Substance.*

The Committee are by no means satisfied that the precautions adopted at Waltham Abbey for the exclusion of grit or other foreign substance from the danger buildings have been adequate to that end; indeed, such conditions as the existence of long-uncovered gangways, on to which grit would be liable to be blown or deposited; the presence of dirty mats at the doorways; the arrangement of moveable boards or planks to enable the workmen to enter and use the "shoe hole" attached to the house without removing their "clean" shoes; the presence of what is called a "clean" mat in the shoe hole, or, as the Committee understand, a mat on to which "clean" shoes may be placed, though the shoe hole itself, in which the mat lies, is "dirty"; the use of the shoe hole on occasion for the taking of meals; the possible re-introduction of dirty,

1054-6, 1535, 1812-5, 1750-1, 1983, 2040, 1537, 1987, 1533, 1876-7

perhaps gritty, sponge cloths into the danger buildings; all constitute gaps in a 1823-4
scheme of precautions for preventing grit and foreign substances from finding their way into the buildings, irrespective of any such deliberate violation of the regulations, as, in view of the laxity which has been shown to exist in regard to the searching of the men, to the exclusion of pockets, &c. (especially at night), may not unreasonably be supposed to be not only possible, but even probable.

There are always in gunpowder factories additional risks of the accidental introduction of dangerous foreign substances, which no system of precautions, however complete or however rigorously enforced, can absolutely provide against.

Thus the master worker mentioned to the Committee that there had been found in a "green charge" in the mixing house, since the accident, a 318
"pebble about half the size of a pea"; on other occasions foreign substances have been found in the prisms themselves. As showing the liability of dangerous 1772
foreign substances to find their way, notwithstanding all precautions, into danger buildings, and even into the gunpowder itself, reference may be fitly made to a list of objects, which was handed in to the House of Commons Committee on Explosives of 1874 as having been "found at various times in the gunpowder works at Waltham Abbey or in barrels of gunpowder at the Government establishments at Purfleet and Woolwich, and at present deposited at Waltham Abbey."* The Committee think it worth while to reproduce this list, for the Appendix XVIII.
purposes of the present report, as an appendix.

Probably any gunpowder maker of experience could furnish testimony in support of the view that the absolute and effective exclusion of grit and dangerous foreign substances is by no means easy; and if in any particular cases—as in that under present notice—the precautions directed to that end prove on examination to be more or less defective, while the occasional violation of regulations cannot, in face of the evidence collected, but be reasonably assumed, it becomes obviously impossible to eliminate the possible presence of grit or other foreign bodies from those causes which may have been operative in bringing about the accident of the 13th December.

The Committee regret that they have not found it possible, on the evidence, to arrive at a more definite conclusion as to the precise cause of the accident. The most careful attention which they have been able to bestow on the subject does not enable them to do more than say that in their judgment it is unlikely to have resulted from the defective working of the machines, seeing that they were found in good working order after the accident, but that it most probably arose from one of the three following causes:—

1. The use or fall of a tool or implement.

2. Lucifer matches.

3. Presence of grit or other foreign substance.

IV.—Suggestions for the Prevention of Accidents.

It remains for the Committee, in connection with this branch of the inquiry, to consider what steps should be adopted to prevent similar accidents in the future.

It would, in the judgment of the Committee, be inexpedient were they to attempt to prescribe precautionary measures in detail. To do so would not only tend to weaken the proper and necessary responsibility of the Superintendent, but would also have the effect of applying hard-and-fast rules where elasticity and an intelligent adaptation to varying conditions are absolutely essential to efficiency, if not to safety.

But the Committee can have no hesitation in stating that the result of this inquiry, though it has not enabled them to place their finger confidently

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* Report of House of Commons Committee, 1874, Appendix 19, pages 366-7.

on the actual cause of the accident on the 13th December, has served the useful purpose of bringing to light very grave defects in the system of discipline and precautions prevailing at Waltham Abbey, and the urgent necessity for a comprehensive revision of the regulations and for the adoption of disciplinary measures for their more rigorous enforcement.

Office of Superintendent should not be liable to avoidably frequent change.

How far the defects of the existing arrangements may be connected with the frequent (too frequent, as the Committee think)* changes of Superintendents in the past, is a question which the Committee have not felt themselves authorized or competent to pursue. They, however, very decidedly believe that it is impossible for an Officer, however talented and in other ways experienced, to take charge of a place like Waltham Abbey at short notice, and to familiarize himself with all the minutiæ of precautionary detail upon the strict fulfilment of which the lives of the workpeople depend at any moment. Again, in the case of a Superintendent newly appointed, it is scarcely to be expected that he will forthwith proceed (even although impelled thereto by his better judgment) to overhaul and revise regulations made or accepted by his more experienced predecessor, and to which the permanent managers of the department raise no objection. He naturally hesitates to disturb existing arrangements, even where he thinks they might be revised with advantage, except upon some strong cause shown, or after he has himself acquired the experience necessary to enable him to act with confidence.

In other manufacturing departments a similiar liability to fatal consequences does not necessarily ensue from any want of familiarity with detail on the part of a newly-appointed Superintendent. At Waltham Abbey, or wherever explosives are manufactured or handled, not merely may the productive efficiency of the factories be impaired by such want of familiarity, but the lives of the workpeople may be imperilled.

Article 317 of the Royal Pay Warrant.

The Committee understand that it has been recently arranged that appointments in the Ordnance Factories shall be held during the pleasure of the Secretary of State, subject to review every five years. The Committee are therefore, strongly of opinion that the office of Superintendent at Waltham Abbey, or wherever explosives are manufactured, should not be subject to frequent avoidable change. They consider it important, moreover, that, when a Superintendent of such a department is to be appointed, special regard should be had to his particular fitness and his technical qualifications for the post he is selected to fill, and that this condition should be regarded as the primary governing consideration in determining his continued occupancy of the post.

Importance of independent inspection.

The Committee are also of opinion that it is desirable that Waltham Abbey and other factories where explosives are manufactured, manipulated, or stored, should be subject to some system of independent and skilled inspection. When the Explosives Act, 1875, was passed, Section 97, which exempts Government factories from its operation, was, it is understood, adopted in a very large degree, because it was considered that the Government department principally concerned, viz., the War Office, could be depended on to secure throughout its factories, without having recourse to the machinery provided for private factories, the same benficial results which the application of the Act, and the introduction of an independent system of inspection were designed to effect in the civil establishments.

With this view the Committee are disposed to concur.

But if it should be found impracticable to secure, through the independent action of the War Department, results corresponding to those which the action of Her Majesty's Inspectors of Explosives has accomplished in the private factories, then, in the judgment of the Committee, it would certainly be in the highest degree expedient that the question of subjecting the Government establishments where explosives are manufactured, manipulated or stored, to the inspection of Her Majesty's Inspectors of Explosives, should be taken into serious consideration.

Enumeration of more prominent definite defects

Turning now in the direction of less general recommendations, the Committee think they will be most usefully discharging the duty with which they have been entrusted by you if they indicate the more prominent of the defects which this enquiry has brought to light.

* The Committee understand that there have, within the past 20 years, been four different Superintendents.

They desire, however, emphatically to guard against the impression that the defects hereinafter mentioned constitute an even approximately exhaustive list. The enquiry has been mainly concentrated upon the particular building and class of work connected with the particular accident under enquiry, and with the sufficiency or otherwise of the regulations in relation to the same. It is quite conceivable, or even probable, that further and fuller enquiries into the working of the factory as a whole would disclose other defects. And this consideration alone would operate to indispose the Committee to put forward anything which could lay any sort of claim to be regarded as a detailed scheme of reform.

The defects which came most prominently under the notice of the Committee are the following:—

Excessive number of persons in cam house.

1. The excessively large number of persons allowed to be present within a single danger risk. 1999

It has been shown that at the time of the accident no less than 11 persons were present in the cam house, and that to this circumstance the resulting deplorable loss of life is directly attributable. It is true that the operation was considered a safe one. 698 But that it was not wholly free from risk had been already established by other accidents in the compressing of gunpowder into pellets or prisms, which had occurred in the private factories of the United Kingdom, and of which the Waltham Abbey authorities can hardly have been ignorant, seeing that they are all recorded, and more or less commented on, in the reports of Her Majesty's Inspectors of Explosives.

Appendix X. contains a list of seven such accidents in nine years, causing the loss of eight lives and injuring two other persons, and the Committee are of the opinion that whether the risk, *i.e.*, the probability of an accident, be great or small, the practice of allowing a large number of persons to be within that risk is objectionable. In private factories the numbers of workpersons in pellet, or prism, houses are narrowly limited as is shown by Appendix IX. Appendix X. *See* also Appendix XI. Appendix IX.

Defective system of searching.

2. Defective system of searching to ensure exclusion of matches, pockets, &c.—This point has been dealt with at considerable length in connection with the examination of the probability of the accident having been caused by a lucifer match, and the Committee have little to add to what they have already stated on the subject.

They will confine themselves to repeating that in their opinion the existing arrangements require to be immediately, completely, and rigorously overhauled, and that searching should in the future be so carried out, whether by night or day, as practically to render the presence, in a danger building, of pockets in any part of the clothing, or of a lucifer match, or steel, or iron, or other dangerous article, an impossibility.

Inadequacy of existing system of supervision of danger buildings.

3. Absence of any system of effective visitation or inspection of the danger buildings.—Whatever may be the case in the day time, it appears clear to the Committee that at night the danger buildings are left very much to themselves. The Committee do not desire to be understood as expressing their opinion that the master millman neglected his duty of visiting the houses at night, but it is quite clear that his visits were in a large degree matters of form, and that when his visit had taken place, which it generally did early in the night, all observation or control from the outside was at an end. They consider that all night visits should be checked by tell-tale clocks or some other mechanical device, and should be made the subject of daily written reports; and, in their judgment, whatever visits may be paid by the master millman or other officials, it would be judicious to supplement them by occasional and uncertain visits by inspectors wholly independent of the masterworker and his staff.

Grave defects in system of repairs of machinery and use of tools.

4. The system under which repairs and adjustments of machinery are effected (in some cases by the workpeople) without clearing the house of powder, and even sometimes without clearing the machine to be operated on, has already been strongly commented upon, and evidently calls for vigorous reform, which should even go to the length of forbidding the presence of any tools or

implements (not essential to their ordinary work) being placed where the workpeople can have access to them. Moreover, a system of daily reports from the chief mechanic as to the condition of the machines and the frequency with which they are overhauled, would seem to be called for in the interest of more thorough efficiency.

Compare 674-6 and 1801-6 with 852-6 and 1532.

Disposal of oily rags and cloths.

5. The arrangements with regard to the removal of the oily sponge cloths were shown to the Committee to be defective, and the practice in this respect differs, as it appears, from what the managing staff of the factory understood to be the rule. In the judgment of the Committee no arrangement can be regarded as satisfactory which does not ensure (as the Explosives Act, 1875, enjoins in the case of private factories) the removal of all oily rags or cloths immediately after use. Section 10 (4) says:—"Charcoal, whether ground or otherwise, and oiled cotton, oiled rags, and oiled waste, and any articles whatever liable to spontaneous ignition, shall not be taken into any danger-building, except for the purpose of immediate supply and work, or immediate use in such building, and upon the cessation of such work or use shall be forthwith removed."

2033

Arrangements for exclusion of grit.

6. The arrangements for the exclusion of grit have been signalised as defective in many particulars, and the Committee feel strongly that very comprehensive reforms are needed in this direction.

Taking meals in "shoe hole."

7. The practice of occasionally taking meals in the "shoe hole" is obviously open to such grave practical objection that the Committee are quite at a loss to understand how it could have been permitted to obtain, and it is scarcely necessary to say that it should be absolutely prohibited.

Unsatisfactory character of existing rules.

8. The rules and regulations have been shown to be, in many respects, very imperfectly adapted to the ends for which they have been framed, and to be open, as Colonel Ford's and other evidence have shown, to considerable criticism in regard to their language, arrangement, and to omissions; moreover, the Committee have been unable to obtain any satisfactory evidence that these rules (such as they are) are properly brought under the notice of, and impressed upon, individual workmen.

597-9, 648 1725-9 1995-6

Absence of proper system of penalties.

9. Further, a system must be regarded as defective when a breach of the rules carries with it no definite penalty, short of dismissal, while in the case of contractors' men and others not in the Government employment, not even this penalty appears to attach to their non-observance.

Limits of quantity of explosive to be more carefully defined.

10. The limits of quantity of explosive assigned to any danger building do not appear to include the quantity in process of removal to and from the house, and on this point the Committee would direct attention to the provisions of that part of Section 24 of the Explosives Act, 1875, which practically effects the inclusion within the allowed quantity of all gunpowder "within the radius of 20 yards from the building, and in course either of removal from the building or of removal to the building for the supply and work thereof."

Further, the Committee think that the limits of quantity allowed in (as well as all rules affecting) any particular building should be kept conspicuously posted up therein (Explosives Act, 1875, Section 10 (6)).

160

Lining of danger buildings.

11. Some evidence was laid before the Committee as to the existence, in the factory, of a building (a granulating house), the roof of which is unlined, and which the Superintendent has in consequence refused to use. In the opinion of the Committee the Superintendent was quite right; no danger building should exist which is not "so constructed or so lined or covered as to prevent . . . . the detaching of any grit, iron, steel, or similar substance in such manner as to come into contact with the gunpowder or ingredients thereof in such building" (Explosives Act, 1875, Section 10 (2)).

As to handing over danger buildings for repair.

12. The Committee are not satisfied that the arrangements under which houses are handed over to the Works Department for repair or alteration, and are again restored to their use as danger buildings are satisfactory. At any rate no specific regulations dealing with this point have been brought to their notice.

The matter may be one of grave import, on the one hand, as regards the risk to the employés of the Works Department which might result from an incomplete removal of all powder and powder dust, or from the insufficient washing out of the house before the repairs were undertaken, or, on the other hand, as regards the risk which would arise if the house were again taken into use as a danger building before all articles of exposed iron or steel or other dangerous substances had been carefully removed. Here again the provisions of the Explosives Act, 1875, Section 10 (5), may be usefully referred to.

Some well considered regulations on this point should be prepared, which should be strictly enforced.

SANDHURST,

F. A. ABEL,

V. D. MAJENDIE, *Colonel,*
Her Majesty's Chief Inspector of Explosives.

F. T. LLOYD, *Major-General, D.A.G.*

R. H. BRADE,
Secretary.

25*th April,* 1894.

LIST OF WITNESSES.

Day of Examination.	Name, &c.	Pages of Evidence.
26th January, 1894 ..	Dr. W. Anderson, F.R.S., Director-General of Ordnance Factories ..	1
26th „ „ ..	Colonel W. McClintock, R.A., Superintendent, Royal Gunpowder Factory ..	1
26th „ „ ..	Mr. Findlay, Master Worker	6
27th „ „ ..	Colonel M. T. Sale, C.M.G., R.E., Superintendent, Building Works Department	12
27th „ „ ..	Captain H. Huleatt, R.E., Second Assistant, Building Works Department ..	12
27th „ „ ..	Captain F. L. Nathan, Officer in charge of Danger Buildings	13
27th „ „ ..	Mr. H. Skinner, workman	17
30th „ „ ..	Mr. H. Craggs, Chief Inspector of Police	20
30th „ „ ..	Mr. A. Beales, master millman	22
30th „ „ ..	Mr. W. J. Chittenden, foreman ..	24
30th „ „ ..	Mr. Edward Jackson, chief fireman ..	26
30th „ „ .	Mr. A. W. Brace, boatman	27
30th „ „ ..	Mr. S. Mumford, workman	28
30th „ „ ..	Mr. C. Wraighte, workman	30
3rd February, „ ..	Mr. G. Ephgrave, foreman	33
3rd „ „ ..	Mr. Johnson, mechanic	37
3rd „ „ ..	Mr. Findlay, Master Worker, *re-examined*	39
3rd „ „ ..	Colonel McClintock, R.A., Superintendent, *re-examined*	42
16th „ „ ..	Colonel A. Ford, Her Majesty's Inspector of Explosives	44

Enquiry into the Accident of 13th December, 1893, at Royal Gunpowder Factory, Waltham Abbey.

WAR OFFICE,

FRIDAY, 26TH JANUARY, 1894.

Present.

Lord SANDHURST, *Chairman*

Members.

Sir F. A. ABEL, Bart., F.R.S.
Colonel V. D. MAJENDIE, C.B., Her Majesty's Chief Inspector of Explosives.
Colonel F. T. LLOYD, C.B., R.A.

Mr. R. H. BRADE, *Secretary.*

Dr. WM. ANDERSON, *examined.*

1. *The Chairman.* You are the Director-General of the Ordnance Factories, I believe?—Yes.

2. Are you at all intimate with the circumstances of the late explosion at Waltham Abbey?—No, not from personal knowledge.

3. Who would be the proper officials to give us evidence with regard to that?—Colonel McClintock, and the master worker, Mr. Findlay, and also, I think, Captain Nathan, the Officer in charge of the danger buildings.

4. Do you think Captain Nathan would be in a position to advise us as to what means should be adopted to prevent such accidents in future?—Yes.

5. Have you any suggestion to offer with reference to the general subject of this enquiry?—Many of the danger buildings at Waltham have been in existence for a very long time, and I am not prepared to say that they are quite in accord with modern ideas as to the construction of such places. For instance, the particular building in which the accident occurred was not, I think, sufficiently sub-divided to provide against occurrences of that kind. There ought to have been only one machine in each room, and the rooms ought to have been divided by brick traverses, whereas the four machines were practically in one room, and I think the great loss of life was due entirely to that arrangement.

6. *Sir F. Abel.* Although the buildings are old the machines have been put there only lately, have they not?—In 1887.

7. Do you know what those buildings were formerly used for?—No, I have no knowledge of that. I have always been told that the operation which was being carried out at the time of the accident was a perfectly safe operation, and from what I can make of the evidence in the case I think the machines had nothing to do with the accident.

(*The Witness withdrew.*)

Colonel W. MCCLINTOCK, *examined.*

8. *The Chairman.* You are the Superintendent of the Royal Gunpowder Factory at Waltham Abbey, I believe?—Yes.

9. Is your responsibility limited to the powder factory?—I have charge of the nitro-glycerine and the cordite factory, as well as the powder factory.

10. With reference to the late explosion at Waltham, when did you first get notice of it?—The explosion actually occurred at about 35 minutes past 2, in the morning of the 13th December. At about 20 minutes to 3 my wife awoke me saying she had heard an explosion, and she said she had also heard a continuous knocking at the door of my assistant's house at the opposite side of the street. I imagined at once that something was wrong, and on looking out of the window I saw that the buildings were burning. When I got to the place the engine was already there trying to put the fire out. I was told that a lot of men were hurt, and shortly afterwards Captain Nathan and Mr. Findlay came down to the place.

11. *Sir F Abel.* What sort of night was it?—Blowing a hurricane and raining hard, and when I got there the wind was blowing pieces of the burning roof away towards the river. After I had been down there about half-an-hour a man in the tail stream was heard calling for help, and it turned out to be Bailey; he must have been in the water a long time before we heard him. Bailey was the foreman in charge of both ends of the house, and his duty was to go from one part to the other to see that all was going on all right

12. *The Chairman.* How many men were working in this particular building when the explosion took place?—The house was divided into two parts, a north end and a south end, the division being caused by a water wheel in the centre. On each side of the water wheel is a wooden wall. The house itself is of wood except the south gable end which is of brick. The explosion took place in the south end, but we do not know what caused it; from there the fire spread to the north end.

13. What was it that injured the men, the explosion or the burning?—One of the men, Watts, found in the south end may have been killed by the explosion, but he was burned so much that this cannot be known. Some of the other men were also badly burned, but the men in the north end were not so badly burned. One of the men saved himself by running at once, but those who hesitated lost their chance.

14. Have you any depositions of the men who have since died?—I think some of them made some statements to Mr. Findlay. One of the men, named Skinner, who got away before the others, was not hurt at all.

15. *Sir F. Abel.* Where was he?—In the north end.

16. *The Chairman.* Was there more than one explosion?—Skinner says he heard two explosions. There must have been some interval of time between them, and that would be the time it took for the powder in one hopper to communicate with the powder in the next machine.

17. Would not the fire of one explosion be communicated to the other powder almost instantaneously?—Are the hoppers kept closed at the top?—They were open then, but now we have them covered.

18. *Colonel Majendie.* What we want to find out is (1) exactly when and how the accident occurred; (2) the quantity of gunpowder, whether in the form of grains or prisms, which exploded or burnt; (3) the effects of such explosion as regards (*a*) personal injury, (*b*) structural damage, and (*c*) injury to machinery and other damage (photographs illustrating these points would be useful); (4) the various possible causes of the accident. Could you hand in a statement dealing with those various points in detail?—Yes, certainly. (*See* Appendix VI.) I have here the statements of the other men who worked the machines, and I think, probably, they will be useful to the Committee. (*See* Appendix VII.)

19. Later on they may be. How many men were killed?—There were 11 men about the house at the time, nine of them were killed, but the other two are at present alive.

20. Are those two unable to throw any light upon the cause of the explosion?—Yes.

21. With regard to the structural damage, have you had any photographs taken?—After the fire was put out some were taken.

22. Is there any photograph of the house as it was before the accident?—No.

23. Are there any drawings of it?—It is a very old place, it used to be a mill.

24. How was the house constructed?—It was of wood, and the roof covered with tarred felt.

25. Was the flooring of wood?—Yes, and covered with leather.

26. What was the thickness of the intervening partitions?—Boards of about half an inch thick, I think; I have not examined them very carefully, but I could get the information from the Engineer's Department.

27. *Sir F. Abel.* Were these machines in the house when you took up your appointment as Superintendent?—Yes, they were started in 1887; I can give you the date on which each machine was set to work.

28. Before that time, was the house out of use, or was it used as a mill?—Whether it was used as a mill up to the date of the machines being put in I cannot say; I did not take up the work until October, 1892. When I got down to the place on the morning of the accident, the whole place was a mass of flame, but there was not a single board blown from the roof, or from the walls, the building was quite intact except the windows.

29. How long did the fire last?—Up to about 4 o'clock in the morning, I think.

30. *Colonel Majendie.* You have referred to two explosions; did you personally hear any?—No, I did not. Skinner says he heard two small explosions in the south end of thebuilding before the explosion occurred in the north end.

31. Does he say that the accident originated in the south end?—Yes, there is no doubt about that. I think Carr has also said the same, but he has not been questioned much, as he is ill still.

32. *Sir F. Abel.* Does the building form two distinct rooms?—There are two distinct rooms, with a covered connecting passage. [The witness then explained the plan to the Committee, pointing out the two streams, the position of the boat, and the landing platform. *See* Appendix I.] The men in the drum house, about 100 yards from the south end, had time to change their shoes and run some distance before the north end explosion took place.

33. *Colonel Majendie.* Were the partitions blown down?—Not that I am aware of.

34. In what direction was the wind?—It was blowing from the east.

35. Was the rain being blown upon the platform?—That platform was completely covered in.

36. Might there have been any powder upon that platform from spillage?—That is very unlikely.

37. Loose powder was carted about there?—Yes, but in barrels covered at the top.

38. Are closed barrels used?—No.

39. *The Chairman.* Are the barrels filled so full as to be capable of spilling as they go along?—No, they contain about 90 lbs. of powder, and that comes up to within about 3 inches of the top.

40. *Colonel Majendie.* They are 100-lb barrels, containing only 90 lb.?—Yes, that is so

41. Was the boat destroyed?—No, but one-half of the top was blown to bits, and the other half shifted forward.

42. Can we get any evidence as to how much was in the boat at the time?—No, I think not, because the boatmen are dead.

43. *Colonel Lloyd.* When you went down to the building on the morning of the accident, did you notice whether the windows were blown in, or blown out?—I did not notice that, nor did I see any glass about the place at all. The window in the south end is blackened on the outside, but that may have been done by the fire.

44. *The Chairman.* Would the glass have been blown into the water?—Yes, perhaps so.

45. *Colonel Majendie.* Have you arrived at any conclusion as to what caused the explosion?—No.

46. Can you state the quantity of powder lost?—About 1,200 lb., I think.

47. Can you divide that amount between the different places; that is to say, between the boat, the barrels which were in the process of being conveyed from one place to another, and the rooms where the powder was being used?—The regulation amount to be in the house was 200 lb. for each machine. The boat had dropped grain at the north end, and had taken away the prisms, and was in the course of repeating the operation at the south end when the accident occurred. There might have been as much as 1,600 lb. between the boat and the two ends, but as a matter of fact, there was only 1,200 lb.

48. Are copies of those regulations as to the quantities which are supposed to be in the houses posted up in the buildings?—Yes; here are copies of all the regulations posted up in the buildings [handing in the same. *See* Appendix V.].

49. *Colonel Lloyd.* Was the boat carrying powder for any other building?—No, it was employed solely for that building.

50. *Colonel Majendie.* At what time do the shift men go to work?—In the ordinary course of things they work from 6 to 6, but as it was just before the Christmas holidays when they are allowed to make up the time spent as a holiday on boxing-day (which is not a Government holiday), they were, at that time coming an hour earlier, and going an hour later, and so working about 14 hours a-day. As a matter of fact, they did not work the whole 14 hours, because they have time off for changing their clothes, and they also have time for a meal in the middle of the night.

51. Who was the actual foreman in charge at the time of the accident?—A man named Bailey, one of the killed.

52. Had he any assistant foreman?—No.

53. Did he do any work at all?—No; his duty was to see that the work was going on all right, and he also had to take the density of the prisms.

54. Had he a machine for doing that?—Yes.

55. At which end of the building was his machine?—At the north end.

56. Then he would not require to leave the house at all?—No, he could pass from one end to the other by means of the covered passage.

57. Do the printed regulations deal with the question of the clothing?—Yes.

58. Do you know, as a matter of fact, whether the men on this occasion were dressed in clothing required by the regulations?—I believe they were; I do not think they would dream of going into the house without having the specially prepared clothing on. All men are supposed to keep a suit of old clothes in the shifting house, which they put on in place of their ordinary clothes when they come in, and then they put on their lasting suit over that.

59. Who sees to that being done?—The foreman is supposed to see to that, and I believe he does see to it; the foreman searches the men on their coming into the house.

60. Does that rule apply everywhere throughout the factory?—Yes.

61. Do they go out in the dinner hour?—They change their shoes when they go into the dining room.

62. Do they always dine in the factory?—Yes.

63. Does a man leave the factory at all from the time of first coming in to the time of finally leaving?—No.

64. Therefore, if his clothing is right when he begins, he has no opportunity of altering it?—That is so.

65. Do you know whether the clothing is invariably inspected by one of the foremen every day; for instance, is there any book containing a record showing that he has carried out his duty?—No, there is no such book.

66. Have you, since you have been there, had any cases of men being improperly dressed brought under your notice?—No.

67. Have you had any cases of men having pockets in their clothing?—No, but since the accident I have had the case of a man who had a pocket hole that was not sewn up.

68. Was there anything in the lining?—No, not in that case.

69. Have you had any cases of men having improper articles found upon them?—Yes I have discharged eight men for having matches.

70. Before or since the accident?—Three before, and five (three in one day) since the accident.

71. Where had they got the matches?—In their waistcoat pockets in their own private clothes. The policeman at the gate searches a percentage of the men when they are coming in; those men said they had not got any matches on them, and when the policeman found the matches they looked surprised.

72. *Sir F. Abel.* Is there any reason for supposing that the searching is more strict since the accident than it was before?—Yes, I have given the Inspector of Police directions to be very particular.

73. *Colonel Majendie.* Where would the private clothing be taken off?—In the shifting room.

74. Would there be anything to prevent a man putting on other clothing in the meal hours?—A man would not be allowed to go into the shifting room during the meal hour.

75. Do they really go there?—No, the man in charge of the room is told to report anyone going there.

76. *Sir F. Abel.* Is the room locked up?—No.

77. *Colonel Majendie.* Supposing a man were cold, would it be possible for him to make an alteration in his clothing in the course of the day?—A man might do that; but the foreman himself, and also the man in the shifting room, would be neglecting their duties if they allowed a man to do so.

78. Would a foreman miss a man in the meal hour?—No; it would be possible for a man to go there then.

79. When and where does the man in the shifting room have his meal?—I cannot say, but probably in the shifting room.

80. The instances in which you have found matches have always occurred before the men got into the factory?—Yes.

81. And therefore in the clothing which, if the regulations were properly carried out, would not be worn in the factory?—That is so.

82. There has been no case of finding matches on a man when at work?—Not in my time.

83. Is there anybody charged with the duty of supervising the foremen, and seeing that they actually do the searching they are required to do, by suddenly making a raid upon the men working in the various buildings, and making them show their pockets?—Yes, if considered necessary.

84. Has it ever been considered necessary?—I have not known of men being searched in the danger buildings.

85. Have you done it?—No; we have very often searched the buildings.

86. Does Captain Nathan do it?—He searches the buildings very often.

87. Does he make it a practice of searching the men at uncertain times?—I think not.

88. *The Chairman.* Does the foreman search all the men to see that they have no pockets, or only every second man?—He is supposed to search them all.

89. Practically there are two searchings, but the first one, I understand, applies only to a percentage?—Yes.

90. *Colonel Lloyd.* What is the percentage?—About 50 per cent. per week.

91. *The Chairman.* Have you ever found any matches lying about within the factory grounds?—Yes; we have found some near the gun-cotton factory and some near the cordite factory.

92. *Colonel Lloyd.* What is the penalty for a man found with matches?—He is discharged on the spot.

93. *Colonel Majendie.* That would apply whether the matches were found at the gate or in his clothing in the danger buildings?—Yes.

94. Supposing a man arriving at the gate finds that he has some matches in his pocket, how can he exculpate himself?—He can hand them over to the policeman.

95. He gets no punishment for doing that?—No.

96. The special clothing worn is supplied by the War Office, is it not?—Yes.

97. Is it made without pockets?—Yes. I am very anxious now that the men should have underclothing for putting on supplied by the War Office, so as to avoid having any private clothing at all.

98. *Colonel Lloyd.* Is there any reason to suppose that a man would shove a box of matches under his shirt?—It would be a dangerous thing to do; besides which, he might be found out.

99. *Sir F. Abel.* Have you ever had a case of surreptitious smoking brought under your notice?—No; I have never found anything of that kind.

100. *The Chairman.* What is your arrangement with regard to latrines?—There are dry earth closets.

101. Have you ever found men smoking there?—No.

102. Do they smoke after meals in the dining-room?—No.

103. *Colonel Majendie.* Is the special clothing universal in every danger building?—Yes.

104. How are the dining rooms warmed?—Those which are not near a danger building have an ordinary open kitchen range, but those which are in a dangerous position are warmed by gas.

105. Would a man working in a danger building be allowed to go into the room which has the fire?—Yes.

106. Where did the men who worked in the house where this accident happened have their meals?—Their dining room was about 80 yards from where the accident occurred.

107. How was that heated?—By gas.

108. Were those men in the habit of going to their night meal together?—Yes, they all went together, the foreman as well.

109. Would they be allowed to bring any portion of their meals into the danger buildings?—No.

110. Would they be allowed to bring a kettle for tea into the danger building?—No, that would be contrary to the rules.

111. Have you ever heard of any irregularities of that sort?—No.

112. How long had the foreman been foreman of that particular house?—For a considerable time, before I went to Waltham.

113. And had the men been in the house for some ime?—They had all been there for more than one or two years.

114. Then there were no recruits, if I may so call them, in the house?—No.

115. Is there anything in the regulations with reference to repairs to the machinery or to the buildings?—In what way?

116. Supposing a machine was found to be out of order, what steps would the foreman, or the workman, or any person who discovered the defect, take to put it right?—The machine would be at once stopped; if it were night time it would have to remain till the next morning, but if it were day time the repairs would be taken in hand at once.

117. Is that formulated in some written order?—No, I think not.

118. If a man found anything wrong with a machine would he be acting wrongly in repairing it then and there himself?—Yes.

119. Is he forbidden to do so?—Yes.

120. Where is the regulation that forbids him to do it?—I cannot say that there is any regulation, but that is the rule. A mechanic is kept specially to do such things as that.

121. Would the foreman carry out such a repair himself?—No.

122. Have you had any cases of that rule being transgressed?—No.

123. Would any instruments be allowed to be kept in those places for repairing the machines?—There would be a spanner there for screwing up the machines.

124. Whose business would it be to do that work?—The mechanic's.

125. Then the mechanic would not have to bring all his tools to the house?—No.

126. *Sir. F. Abel.* Would he be close at hand?—Yes, in the day time, but at night the machine would have to be stopped if anything went wrong.

127. *Colonel Lloyd.* Would the repairing of one machine cause the stoppage of all the other machines in the same house?—Yes.

128. And would all the powder be removed from the house while that was going on?—Yes, that is the rule.

129. *Sir F. Abel.* What is the object of keeping a spanner in the house if the men are forbidden to use it in any way?—It is to obviate the necessity of carrying all the tools about, I suppose.

130. *Colonel Majendie.* Would not the presence of the spanner be to some extent a temptation to the foreman?—All the machines were working when the explosions occurred, a spanner could not be used when the machine was in motion.

131. How do you know that all the machines were working?—The firemen who got down there first told me that they were working; the wheel was working the whole of the time, and it was only stopped by the roof falling in.

132. *The Chairman.* What were the machines used?—Cam machines.

133. Are they so constructed that part of the machine comes down, and part comes up in pressing a prism?—Yes, two parts meet together in order to press the grain powder into a prism.

134. There is a drill, is there not, in the centre of the prism?—Yes, a pin runs up the centre of the bottom plunger, and enters the bottom of the top plunger.

135. It sometimes occurs, does it not, that these machines get clogged?—Yes, that is a characteristic of these machines; the dust gets down between the pin and the plunger.

136. How is the clogging discovered first of all?—They would find that out by the friction, and the stiffness in the working of the machine.

137. Would the prism be faulty in shape in any way?—No.

138. What are the pins made of?—Gun metal.

139. How are they cleaned?—They are washed out with water.

140. Who does that?—The men themselves, under the supervision of their foreman.

141. In the case of one of these machines getting clogged, would that necessitate calling the foreman, or would the men put it in order again on their own account?—The whole of the machine would have to be stopped in order to wash it out, and I presume the men would call the foreman.

142. *Colonel Majendie.* I see that some of the rules refer to particular houses; here for instance are the rules for the cam house, are those the only rules applicable to that house?—Besides the particular rules, the "general" rules would also apply to the particular houses.

143. Is there anything else posted up?—No.

144. How are the prisms taken away?—They are taken away in covered trays.

145. Where do they take them out?—Through *this* door (*see* Appendix I.), and along the passage to the boat; the boat which brings the grain takes away the prisms.

146. But the powder is in the form of grain when it comes here?—Yes.

147. Has it been dried?—No.

148. What amount of moisture would it contain?—About 8 per cent.

149. What particular powder is it?—E.X.E.; it is rather a quicker powder than the brown powder.

150. What is it used for?—For the 6-inch B.L. gun, and I think also for the 12·5-inch M.L. gun.

151. Had that particular powder been made up for some time in this particular house?—Yes; we made it for seven months last year, the work of the house had then to be stopped in order to get in a new waterwheel, and I think we had been working again about taree weeks when the accident happened.

152 Had there previously been any other accident in this house?—No.

153. And, with regard to the powder used at the time of the accident, was it in all respects similar to what had been used before?—Yes, there had been no variation.

154. With regard to the ingredients, do you know whether they were the same as you had been using for some time?—Yes.

155. Had you changed at all the sources of supply?—No.

156. Can you tell us what precautions are taken in order to prevent any foreign substances getting into

the powder?—The sulphur is put through a sieve, the charcoal is also put through a fine mesh; the saltpetre is not because it is damp, but the mixed ingredients, after mixing, are put through a sieve.

157. In that sifting, after mixing, have you found any foreign substances?—Yes, about three days after the explosion I found, in the sieve, a pebble, about the size of a pea. It is a long time since we found such a thing as that.

158. Can you say at all where that came from?—No, I have no idea.

159. I suppose the ingredients, from the time of sifting, are all kept in clean houses?—Yes.

160. Are all your powder buildings wood lined, are they lined with anything?—Yes, with only one exception, but I have not used that house because it is not lined; my predecessor declined to use it, and I have done so, too.

161. The ingredients are sifted, and the foreign matter presumably excluded, but in what are they carried from one house to another?—After the mixing they go to the mills sometimes by tram, sometimes by boat; the boats are always covered.

162. Then nothing could fall in while the boat was passing under a bridge, for instance?—No.

163. And are trams similarly covered?—Yes. In some instances the ingredients go to the drum house, and then they do not want milling for so long; but otherwise they go straight to the mill.

164. Do you think the houses are properly constructed as far as the lining goes; is there any opportunity for bits of brick or other particles getting into the mixture?—Not in the houses we use at present.

165. But with regard to those you were using at the time of the accident?—One of the granulating houses had a slate roof, and I have asked that that roof may be replaced.

166. Had this powder been through that granulating house?—I cannot say.

167. Is that a new house?—No, it has been in existence for some years.

168. Can you tell us how the house where the accident occurred was lighted?—By electric lamps, and they were entirely outside.

169. Did the wires pass into the house in any way?—No.

170. *Sir F. Abel.* Were the electric lights enclosed in water?—Some of them, not all.

171. The enclosure in water would prevent even a remote possibility of fire getting into the house?—Yes, and it would also prevent the powder dust staying about the lamp.

172. *Colonel Majendie.* Was it at all a dusty house?—No; though, of course, there might be some dust from the prisms.

173. Was there any dust about outside?—No.

174. Had you been in any way concerned with putting up the electric light?—No.

175. Has that been put up since you went there?—It has been altered since I went there.

176. Are you satisfied with it?—Yes.

177. So far as you could see, was there anything in the electric light that could endanger the place?—No.

178. Do you propose to hand in any description or drawings of the machines?—I can hand in some photographs and descriptions of them if required to do so.

179. Are there any working drawings of the machines; who supplied them?—They were got from Germany. When we got them first they were made entirely of steel, but we found that in the working they got quite rough.

180. *The Chairman.* Had you any accidents with them when they were all steel?—No. The steel bushes, and pins, and plungers were all removed, and replaced with others made of gun-metal, and that was found to be an improvement. We found that the saltpetre acted injuriously on the steel.

181. *Colonel Majendie.* Will you supply us with working drawings of the machines if possible?—Yes.*

182. Are you, as Superintendent, personally responsible for the working of the machines?—Yes.

183. Have you been satisfied with these particular machines?—Yes, quite.

184. Have you received any complaints with regard to them?—None whatever, except after the accident.

185. What were the complaints then?—At the inquest, two of the men said the pins got heated.

186. And no fault of that kind was brought to your notice before?—No.

187. *Sir F. Abel.* Was there not some statement made at the inquest to the effect that a plunger was destroyed?—After the accident a plunger was found broken, but it was evident it must have got broken after the accident took place. A large iron screw, about 2 inches long, was found in between the bush and the plunger, and we think it must have fallen from the roof, because such a thing could not possibly have got into the room in any other way.

188. *Colonel Majendie.* Had you ever received reports as to broken plungers before that?—Yes; about three days before the accident a plunger broke, and the mechanics had to put in a new one. They are now made of phosphor-bronze, or gun-metal.

189. Who replaced it on that occasion?—The fitter.

190. Do you know the man?—Yes.

191. Before he replaced the plunger, was the house absolutely cleared of powder?—I should imagine so.

192. It ought to have been?—Yes.

193. Is it a usual thing to replace plungers during night work?—It takes some little time to do it.

194. Can a foreman do it, or must a mechanic do it?—The foreman, I think, could do it.

195. *Sir F. Abel.* Is a spanner the only instrument required?—A turnscrew and a spanner.

196. *Colonel Majendie.* Were they both kept there?—Yes.

197. Have you known many cases of accident in this class of house before?—No, none except the breaking down of machines.

198. I understand it was a stormy night. Was there any lightning?—Not that I saw.

199. Have the buildings lightning conductors?—Some of them have, but I do not think this building had one.

200. *Colonel Lloyd.* Was it an open slate roof?—It was a wooden roof covered with tarred felt.

201. Was any mortar or cement used in its construction?—No, except in the south gable end, which was of brick.

202. *Sir F. Abel.* Was it whitewashed inside?—No, I think not; it was match-lined and varnished.

203. *The Chairman.* Do you think that felt roofs are dangerous?—Yes, I think they should be replaced by zinc.

204. I understand the floor was covered with leather?—Yes.

205. How was it kept down?—It was nailed down with copper nails.

206. *Colonel Majendie.* Where is the nearest building with any fire in it?—The water warder's cottage and the dining room are about 70 yards off, towards the north.

207. If there were sparks would they be carried towards this building?—No; there is no coal fire allowed in either of these houses, only gas.

208. Where was the nearest chimney of any sort?—The steam mill, which has a high shaft, about 130 yards off.

209. Have you any locomotive engines running in any part of the works?—No, none at all.

210. So far as you know was there any external source from which a spark could have reached the house?—No.

211. What are your regulations with reference to the use of cotton waste and things of that sort?—

* The witness subsequently supplied the Secretary with photographs of a cam machine which are to be found in Appendix II.

None is allowed in the building at all; there is a receptacle outside the building where they can put the sponge cloths; cotton waste is not used.

212. Where did that receptacle stand with reference to this particular building?—It was at a safe distance from the building.

213. What lubricating oil do you use?—We use a machine oil which appears to be a sort of mixture.

214. It is not wholly a mineral oil?—I think not, but I cannot say accurately.

215. So far as your knowledge goes is the work as carefully carried out at night as in the daytime?—Yes.

216. Is it the case that night work has been stopped since the accident?—No.

217. Do you see any reason why it should be stopped?—No. I should like to point out that we have had only four fatal explosions since 1840. The first happened in 1843, at 2 o'clock in the afternoon; the second in 1870, also at 2 o'clock; the third in 1890, at 6 o'clock in the morning; and the fourth last December, in what may be called the middle of the night; so you see only one explosion has taken place in the night since 1840.

218. *Colonel Lloyd.* Is any inspection made by any outside official at uncertain times of the night?—Yes, the master millman has to go through all the houses in the night. Occasionally my assistant goes through the houses, and I do the same.

219. Does the master millman make any reports of his visits?—No, not to me, but he might to the master worker.

220. Would he be the official who would notice any irregularities?—Yes, but there is no check upon him.

221. *Colonel Majendie.* Have you a system of tell-tale clocks?—No.

222. With regard to the men working in the house had you any personal knowledge of them, could you say whether they were in a proper mental condition?—I believe they were all intelligent and steady men.

223. Had you any idea that any of them had, say, a desire to commit suicide?—I have had no knowledge of that.

224. Had they been working there for some time, and were they sane and sober men so far as you know?—Yes.

225. They had to come in at 5 o'clock, I understand?—Yes.

226. Could any of them get out at night?—Only if one of them became ill, and then the foreman would have to pass him out.

227. *Colonel Lloyd.* It appeared, I think, in the report of the inquest, that there was some heat in the machines, will you state to the Committee the temperature at which gunpowder explodes, and say what reference that would have to the temperature of the machines on which a man could only just bear his hand?—I think you cannot bear your hand on anything over 150 degrees, and gunpowder, I understand, ignites at somewhere about 500.

228. Have you ever heard of any instance in which one of these cam machines exhibited such heat that a man could not bear his hand upon it?—No; two men stated that at the inquest, but I have by me the evidence of a number of men in contradiction of those statements.

229. Will you append that to the report you are going to make for us?—Yes (*see* Appendix VII.).

230. *Colonel Majendie.* Were those men paid piece-work, or time-work?—There is no piece-work whatever.

231. Were they then being paid at the rate at which they had usually been paid?—Yes.

232. There has been no alteration recently in their rate of pay?—That is so.

233. Then they would have no pecuniary advantage in hurrying their work?—No, they had ample time to get their task through.

234. If a man saw a machine damaged would he have any personal interest in correcting that without sending to the mechanic?—No, none.

235. Would he lose any pay by such damage?—No nothing at all.

(*The Witness withdrew.*)

Mr. FINDLAY, *examined.*

236. *The Chairman.* You are employed in the Royal Gunpowder Factory, I believe?—Yes.

237. What is your position there?—I am the master worker; I have the management of the men in the gunpowder branch, and also of the men in the gun-cotton branch.

238. Is your position equivalent to that of a general manager in a private concern?—Yes.

239. For how long have you been employed at Waltham?—33 years last December. I entered as an apprentice under my father; I worked in every department as an apprentice first, and then afterwards as a workman. My father was master worker there before me.

240. *Colonel Majendie.* How long has this house been used for its present purpose?—Since 1887.

241. What was it used for before that?—Formerly it was what was called the No. 10 mill, it was one of the older mills, and was used as an incorporating mill with two pairs of runners.

242. Was the construction of the house at the time it was a mill similar to what it is now?—No; at the time the cams were placed in it the building was match-lined with a wooden false roof over that.

243. What was the construction of the building at the time of the explosion?—Felt roofed outside, I think.

244. How was it lined?—Match-lined boards, and varnished.

245. *Sir F. Abel.* How was the roof protected?—By an inner roof, match-lined, too. The outside of the roof was tarred; the sides were wood and tarred; one end, the south end, was brick, and the other end was of wood.

246. *Colonel Majendie.* Were there two cams in each part?—Yes.

247. Were there any openings in the partitions near the water-wheel?—No doors, but there were shafts, one on each side of the water-wheel.

248. Then the shaft passed through the partition into the house?—Yes.

249. Could any dust get through there?—I do not think it possible.

250. Could a flash pass through?—I do not think so.

251. Why not?—In the first place, the water-wheel was going at the time of the accident, and all the inside woodwork is as good now as when it was first put there; there is not a scorch on it at all, but the outside is burned.

252. Then are you distinctly of opinion that there was no flash of flame through the partition?—Yes.

253. *Colonel Lloyd.* Is there a bearing for the shaft where the partition wall is?—Yes, inside.

254. Would that completely close the hole?—The woodwork comes close round the shaft up to within, perhaps, one-sixteenth of an inch.

255. *Colonel Majendie.* Those partitions were not calculated to resist an explosion, were they?—No, they were not put up with that idea.

256. Was the floor covered with leather?—Yes.

257. All over?—Yes.

258. With regard to the passage which ran along in front of the house, was there leather on the floor there?—No, only wood, it was a clean floor.

259. Was the floor all on the same level?—No, the old mill floor was covered with another floor, and I should say that was about 9 inches or 10 inches above the old floor; the floor was really made level to the base of the cam machines.

260. Then in bringing powder into the house, one would have to step up a little?—Yes.

261. How did the men bring the powder into the house?—There is a platform direct from the river here. [The witness then described, by means of the plan the procedure followed in bringing powder from the boat to the house, and said there was a slight variation to the usual course on the night in question (the platform from the water to the house at the south end of the building not being used) which he understood from one of the men was owing to the very high wind that was blowing.]

262. Was the proper way of getting a barrel along to roll it on its chine?—Yes.

263. Have you, in the course of your experience, ever known men to take barrels along in any other way?—No, I have never seen a man drag a barrel along.

264. How would a man get it on to this step (*see* spot marked B^1 on the plan, Appendix I.)?—He would tilt it half way up, and move it on the side or lift it.

265. *Sir F. Abel.* Do you think there would be any possibility of a man stumbling there, and the barrel being thrown down, and the man falling on it?—No, and even if he did, I fail to see what harm would come of it.

266. *Colonel Majendie.* Could the man see?—Yes.

267. How was the passage lighted?—There was an electric lamp opposite the middle of the water-wheel which showed a light in the passage itself.

268. *Sir F. Abel.* In bringing the powder into the house would a man always have clean shoes on?—Yes. [The witness then pointed out on the plan the position of the places for changing boots, and said he had found the boatmen's dirty boots on board the boat, which proved that they had not put on their clean boots in one of the rooms.]

269. *Colonel Majendie.* Is the inside of the boat treated like the inside of a powder mill?—Yes, certainly.

270. About what time after the accident did you reach the works?—The explosion occurred at 25 minutes to 3, and I arrived there about a quarter past.

271. Did you see anything on the remains of the man Watts which pointed to an explosion as distinguished from burning?—I could not tell, he had no limbs, he was burned almost to a cinder.

272. Were any of the others injured as much as he was?—No; I think he was killed on the spot where he was. [The witness then explained, by means of the plan, how the men got out of the various buildings, and how they were able to assist each other.]

273. Was there any evidence of the explosion of any quantity of gunpowder at any other part than where the body of Watts was found?—When I got to the place it was in flames, and I had no means of seeing anything more than any one else could see.

274. Is there any evidence of a crater *here* (*i.e.*, where the body of the man Watts was found, *see* Appendix I.)?—No.

275. Was any portion of a barrel found *there* (*i.e.*, where the body of the man Watts was found, *see* Appendix I.)?—No.

276. Was anybody able to see what Watts was doing at the time of the explosion?—The wounded men told me as much as they knew of what happened. [The witness then described, by means of the plan, how and where Watts and Bailey were employed at the exact time of the explosion (Bailey in passing from the south to the north end of the building met Watts rolling a barrel of powder into the south end), and also what action the other four men took at the same time.]

277. *Sir F. Abel.* They used E.X.E. grain, did they not?—Yes.

278. Does that produce any violent effect, even if exploded in a granulated condition?—No.

279. It differs very much from the ordinary S.G., does it not?—Yes, and the density of the grain in this condition is such that it burns as slowly as a prism; in fact, the density of the grain very nearly equals that of the prism.

280. And in addition to that, how much water would it contain?—About 4 per cent.

281. Then you could not possibly expect to find a crater?—No, we can hardly say it exploded, it burned; and that is shown by the fact that some men working in the drum house had time to put on their boots, get their electric lamp out of their cupboard, and get within 30 yards of the house before the other explosion took place.

282. *Colonel Majendie.* When Bailey met him, was Watts rolling a barrel?—Yes.

283. How much did the barrel contain?—About 90 lb.

284. Can you say what powder was in the boat?—The boatmen had emptied one house, and the man was taking a barrel of grain towards the other; I find there are about 12 barrels short of what was in the boat and what was in the house.

285. Do you think that the whole stock of powder that went off was 12 times 90 lb.?—Yes.

286. And nearly all of that was in the form of prisms, was it not?—Except those two barrels which had been put in the north end, one barrel Watts was rolling and one in the boat.

287. Is the boat very considerably injured?—Yes; but the bottom of the boat is not hurt, although it leaks a little at the side. The half of the top where the barrel of powder was is pushed off the top.

288. If there had been anything approaching an explosion the boat would have disappeared, would it not?—Yes.

289. Even with the explosion of 100 lb.?—Yes.

290. *Colonel Lloyd.* Is any part of the boat to be seen now?—Yes, one half of it, the other half is broken to pieces.

291. *Colonel Majendie.* When were you last in this particular house?—On the Monday, the accident occurring early on the following Wednesday morning.

292. Were the same persons there on the Monday as were employed there on the Wednesday when the accident happened?—I was there at the time of the day shift only, and not when the night shift was there.

293. Were those men accustomed to being employed in the same house?—Yes.

294. Were they familiar with the whole of the working of the house?—Yes.

295. Were any of them new hands to this particular work?—No, they were old hands at it.

296. How long has Bailey, the foreman, been working in that house?—Ever since it started, in 1887.

297. Was he a good man?—Yes.

298. What would you say with regard to the others?—They were the best lot of men we ever had.

299. Was there anything strange in the conduct of any of them, anything which attracted your attention?—No.

300. *Colonel Lloyd.* Would especially good men be selected for specially hazardous employments?—These four men were selected on account of their good conduct and ability.

301. As a rule are hazardous employments given to selected men?—Yes; we select all our men.

302. *Colonel Majendie.* Did you regard this as a

specially dangerous house?—No, nothing beyond the general danger attaching to the making of gunpowder.

303. *Sir F. Abel.* I believe you went to Germany to see the working of these cam machines?—Yes.

304. And you came to the conclusion that they were safe machines?—Yes,

305. And were the machines in this house similar to those you saw working in Germany?—Yes, generally.

306. Had they been altered at all?—Yes, we had taken the steel pins and bushes out, and put phosphor-bronze ones in in their places. Those alterations were made upon my recommendation. I found that in the working the steel pins got scored.

307. Will you describe generally the principle of the cam machine?—The press consists of six moulds which are made of bronze; the grain is fed into them by a sliding table, having six fillers of gun metal, which are themselves fed from a hopper, into which the grain is poured; the table moves backwards and forwards, and besides serving to carry the charges it pushes forward the prisms after having been pressed, There are two sets of plungers of bronze, top and bottom; through the latter, which serve as guides, pass the bronze needles which form the channels. The upper plungers have holes into which the needles pass when they come down to give the pressure. The whole is worked by means of eccentrics.

308. Did you hear of any accident with those machines having occurred in Germany?—No, and they went in and out of their houses with dirty boots.

309. *Colonel Majendie.* Were those alterations in the machines made long since?—Yes, we did not work them in their original form for long.

310. How long had this house been engaged with this particular class of work?—We worked it from the 1st of April, of last year, up to the end of September, and then we had to put in a new water-wheel, the other being a very old one, which had belonged to No. 10 mill. With the new wheel, we had been working six weeks when the accident happened.

311. And during that time had there been any special alteration made?—No.

312. And no accident of any kind from explosion or from fire?—No.

313. With regard to the stuff you were making, had you any cognizance of the sources from whence the saltpetre, and sulphur and charcoal were derived?—The saltpetre belonged to someone else, but the charcoal and sulphur were in my charge.

314. And on the night of the accident, were the charcoal and sulphur the same as had been used since the house was reopened?—Yes.

315. Were they subjected to the same sort of examination?—They were passed through a 32 mesh, and then when they were mixed with the saltpetre, the whole of the mixture was passed through another sieve.

316. The object of that was, I presume, to exclude dangerous foreign substances?—Yes.

317. Have there been any, or many, cases in which you have found something?—No, we have never found anything except bits of wood, or a copper nail.

318. Has anything been found since the accident?—Yes, we found a stone on the mixing house sieve, a pebble about half the size of a pea.

319. Can you suggest how that came there?—No.

320. What was it found in?—In the mixture of saltpetre, sulphur and charcoal, but as the two latter had been passed through a 32 mesh, the supposition was that it might have come in in the saltpetre, but we cannot say for certain.

321. There have been, I suppose, from time to time all sorts of things found in the ingredients at Waltham Abbey?—I do not know.

322. Do you not know of a room where a number of such specimens were kept?—We have found such things in the powder, but not in the composition.

323. Have you in this particular composition and powder found anything at any time?—No.

324. Does the powder go into any unlined house during the mixing of the ingredients?—The mill is an unlined house, it has only a single roof.

325. What is the roof made of?—Wood, the walls are of brick.

326. Are they lined?—No.

327. Whitewashed?—Yes.

328. *Sir F. Abel.* Is the wooden roof whitewashed?—I do not think so. I think it is only painted.

329. *Colonel Majendie.* Are the walls in such a condition that any brick particles could become detached from them?—No.

330. Could any particles become detached from the roof?—No.

331. What is the next house?—The breaking-down house, which is of wood and iron.

332. Could any grit become detached there?—No.

333. What is the next house?—The press-house, that has a slate roof lined inside with wood, and so has one of the granulating houses, but not lined inside, but this particular powder did not pass through that house.

333*a*. Are you satisfied with an unlined roof?—No, I am not.

334. *Sir F. Abel.* Is that granulating house a modern house?—It is an old house, about 50 years old.

335. *Colonel Majendie.* Has it ever been lined?—No.

336. Is it now used?—It has not been used since the accident.

337. What is the next house?—The dusting house, which is also of wood.

338. *Sir F. Abel.* Are the hoppers of the cam machines provided with lids, or are they open?—They are open.

339. *Colonel Majendie.* How are the linings fastened on in the houses you have detailed; are they nailed on?—The new houses have iron girders, with iron screw-bolts supporting the girders, but the iron bolts are covered with leather.

340. Do you think it at all possible that a nail, or a portion of a nail, may have fallen from the roof of any one of those houses into the powder in passing?—No, I think not.

341. Will you tell us what happened after the powder was brought into the house?—Rudkin would put it into the hopper. [The witness then explained how the man carried out the various operations, pointing out that the amount of powder put into the hopper considerably affected the process of output and the density of the prism.]

342. How much does the hopper contain?—As near as possible 40 lb.

343. What is the hopper made of?—Gun metal. The man in front of the machine sees that the charger comes over the bushes and sees that the charger pushes the prisms off; he then puts the prisms on a tray. There are 24 prisms turned off in a minute.

344. Are they arranged on the trays by hand?—Yes, a full rack holds 280 prisms. That is all the men have to do while they are actually at work; and the order is, if anything gets out of gear—for instance, such as a charger not coming far enough over to push the prism off, or say a plunger did not come forward enough to push a prism out—then the machine would have to be stopped. The object of having two men there is to see that those two operations are properly carried out. [The witness then explained, by means of a diagram, how the working of the levers was carried out when the charger or the plungers got out of order.]

345. Had you had any complaints from anybody about anything regarding the machines?—No, no complaints. Sometimes I went in and asked Bailey, "is everything all right?" and perhaps he would say "yes," or "one of the pins got stopped up and took a little longer to clean."

346. Had you any complaints about the pins getting bent?—No. In 1887 the pins were constantly broken, because when the powder gets dry in the plunger the pin is snapped off at once; we therefore made holes in the plungers, and water was put in to clean them

347. *Sir F. Abel.* Are they washed periodically?—The foreman has the discretion of cleaning them after one, two, three, or four cases, but four is the outside limit.

348. They do not wash them until they have a difficulty with the machine?—They always wash them when they have done four cases of prisms; but they do not wash them before that unless there is a difficulty.

349. *Colonel Majendie.* Have you had any complaints made to you about these machines being dangerous?—No.

350. Was not something said about them at the inquest?—Yes, about the pins getting heated; but that was not true.

351. Such a thing has not, at any rate, been represented to you?—No.

352 Would it have been Bailey's business to have represented that to you?—He would not have waited to represent it to me; if he had only thought there was something wrong he had written instructions to stop at once.

353. *Sir F. Abel.* Is the breaking of plungers of frequent occurrence?—Yes.

354. To what is that due?—To the metal, I think.

355. Does the fracture occur suddenly?—Yes, either in the coming up or going down.

356. *Colonel Majendie.* What happens when a plunger is broken?—It disables the machine, and no work can be carried on.

357. When a plunger breaks in one machine, is the whole house stopped?—No, not the whole house; that particular machine is stopped independently of the others.

358. *Sir F. Abel.* When a plunger does break what is done?—If it is in the daytime, the engineer comes and replaces it by another one.

359. *Colonel Majendie.* Does he remove all the powder out of the house?—Yes, every portion of it.

360. Is the house washed out?—No.

361. *Sir F. Abel.* Does he bring his tools with him?—Yes.

362. Then what is the object of a steel spanner being left in the house?—There are a lot of spanners belonging to these machines which are always hung up in the house.

363. But why, if there is only one man dealing with the spanners, does he not bring them along with him, the same as he brings his other tools?—Those tools may be used by the foreman; if he found that the plungers got compressed he would undo the two screws, and put some packing under.

364. Supposing the foreman were not there, would one of the men take it upon himself to do that?—No.

365. *Colonel Majendie.* Are the men forbidden to do that?—Yes.

366. Is there any written order?—No.

367. How does a man know that he may not do it?—There is a foreman in charge of the whole thing, with instructions that he is the only one to do it.

368. But not written instructions?—No.

369. *Sir F. Abel.* Is there any other tool besides a spanner kept in the house?—Yes, a hammer and another spanner, to alter the wedges on the cross-head.

370. Would the foreman do that?—Yes.

371. *Colonel Majendie.* Would he be required to clear the house of powder to do that?—No, because sometimes the cross-head wants to be altered every five minutes.

372. *Sir F. Abel.* What is the object of that?—The density of the prism alters, and the crosshead has to be altered accordingly.

373. *Colonel Majendie.* Would he clear the house before using the spanner to alter this wedge?—No.

374. Is that a steel spanner?—No, it is a metal one.

375. But, in using a steel spanner for that, would he clear the house?—No.

376. *The Chairman.* How is the powder put into the hopper?—By a copper bowl, out of the barrel.

376*a*. Would the powder be littered about at all?—No, it is practically a clean house.

377. *Colonel Majendie.* All the men in the danger buildings throughout the factory have to wear a special suit of clothes, have they not?—Yes, a frock, trousers, and a cap.

378. Is it a flap cap?—Yes.

379. Do they wear those special clothes over their ordinary clothing?—Over the clothing to be worn in the powder house, and we require that there shall be no iron buttons and no pockets in that private clothing.

380. Where is that private suit kept?—In the shifting room.

381. Has each man a locker?—At the present time there is one locker between every two men.

382. A man never takes his Government clothing out at any time?—That is so.

383. Whose business is it to see that the men have got on proper clothing underneath their Government clothing?—There is a man specially appointed to the shifting room, a day man and a night man. The man does not inspect every one, but, of course, he looks to see that they have changed their clothes. The foreman looks also to see that the men have changed their clothes, and that they have no pockets.

384. Does the foreman or the shifting-house man keep any record of that?—No.

385. Where is the shifting-house?—Two hundred yards from this house.

386. *Sir F. Abel.* Do the bargemen go through the same operation of changing?—Yes.

387. Where do they change?—Near the Superintendent's office.

388. Who keeps a watch upon them?—A man there.

389. *Colonel Majendie.* When did Bailey look at his men?—When they came to work first.

390. In the house?—Yes.

391. Had they any chance of changing back into improper clothing during the course of the day?—No, they could not do that.

392. Have you had any instances of men being reported to you for having pockets in their clothes?—No.

393. Never in all your experience?—No.

394. And you yourself have never found a man with them?—No.

395. Nor with metal buttons on their clothes?—No.

396. Or buckles on their braces, and things of that sort?—No. I have myself cautioned almost every man upon those points when they first came.

397. You say that Bailey would look at his men every day?—Yes, each foreman is supposed to do that, and they are asked if they have done it.

398. Are those rules as strictly observed at night as they are in the day?—Certainly.

399. Have you any reason to doubt that?—No.

400. *The Chairman.* We understand that the master millman goes round the works?—Yes, we have two, one for the day and one for the night; they work alternately.

401. Do they inspect the men in the same way as you might do occasionally?—No, not on going round in the night time.

402. Is there any check upon that master millman to show that he has been round?—He reports verbally, not in writing, to the other man coming on in the morning, and says whether all is right or not.

403. *Colonel Majendie.* Do you think there is any objection to the night work?—I do not see any objection to it.

404. Do you think that the men can be quite as easily supervised at night as in the day time?—Yes, especially as we use the electric light.

405. I understand that there have been cases of men being found coming into the works with matches on them?—Yes, that is so.

406. But never a case of a man being found in the works with matches in his possession?—Only one case during the 13 years that I have been the master worker.

407. Have there been many cases of matches being found in the works but not on the men?—I have

myself repeatedly found matches about the grounds, but I am of opinion that they were carried in on the men's boots. The men on coming to work feel in their pockets to see if they have any matches, and if they have they throw them down on the ground outside, and then other men coming in are liable to tread on those matches and so bring them into the works on the soles of their boots.

408. If a man finds he has matches in his pocket when he gets to the gate, what does he do?—Gives them to the policeman; in fact, they are asked the question.

409. Every man?—No, not every man.

410. *Sir F. Abel.* On what occasions have men been dismissed for having matches in their possession?—The policeman has always the power to search a man, and if a man is found to have matches after he has been asked, and says he has none, then he is reported, and dismissed at once, but if a man gives up his matches on being asked, then he is let alone.

411. *The Chairman.* Were the matches you picked up about the grounds live matches?—Yes.

412. *Colonel Majendie.* Have you had any cases of matches being found since the explosion?—Yes; we have sent away three men and one boy for that reason. The men had been taken on only in the last fortnight, and when they came they were particularly cautioned against carrying matches, and they were told that if they did smoke they were never to carry matches in their pockets. It appeared they had been smoking over-night, and had put the matches in their pockets, and had forgotten them.

413. You think they did not keep them there intentionally?—Certainly not.

414. *The Chairman.* Do you admit of any excuse?—No, none at all.

415. *Colonel Majendie.* Are you satisfied with the electric light?—I am satisfied so far as regards that house.

416. Had that been altered?—Yes, some time before; it was entirely outside the house.

417. I understand there was no other means of lighting except by the electric light, and no means of heating the place?—Yes, there was some heating done by means of pipes.

418. Where was the steam generated?—In a boiler, about 100 yards off.

419. Were there any fires at all near this house?—No; there used to be a large fire in the dining-room, but about 18 months ago we had it done away with, and we put a gas-stove in instead.

420. Could there be any place at all near there from whence a spark could be derived?—No, that would be impossible.

421. Have you tried to find out the cause of the explosion?—Yes.

422. Have you found out anything with regard to the machines which you think suspicious?—No; when it got daylight on the morning of the accident, we went and examined the machines, and we found that one of the top plungers had got jammed in the bush with a large iron screw that had evidently come out of the old building somewhere during the fire, because the machines were working after the accident

423. What evidence had you that the machines were working after the accident?—The Colonel saw them and the firemen saw them, and I saw them as the building kept falling in; they were all working.

424. They could not have worked with a broken plunger jammed as that was, I presume?—No, that was broken afterwards; the screw fell across the bush and that is why the plunger was broken.

425. Have you got the screw?—Yes.

426. Has it been shown to the Officers of the Works Department?—I do not know; it could not have tumbled into that place until the lining had got burned. There were eight or nine of those screws lying about, some on the same machine, and some on the next machine; I picked up five myself.

427. And you think they had nothing whatever to do with the machine?—No.

428. Has anything occurred to shake your confidence in these machines since the accident?—No.

429. Have you heard of any accident elsewhere in the process of pressing prisms?—No.

430. Do you not know that one happened at Dartford some few years ago?—Yes, but I believe that was not a cam machine; that was a hydraulic press, something similar to our own, except that they had compensating plungers. That accident happened, I believe, while they were pushing the prisms out.

431. There was no explosion in that case, was there?—No.

432. Were all the prisms burned?—No, only that one, I believe.

433. Then may we take it that the results of that explosion would rather tend to strengthen your impression that this was not a very dangerous house?—I do not consider it dangerous.

434. Was the question ever mooted, or discussed between yourself and the Superintendent, or anybody else, as to reducing the number of persons in that house?—That could not have been done without taking away some of the machines.

435. Could not the machines have been divided?—No, the house was not big enough for that.

436. But with regard to this particular building, has the question of placing as many as eleven people in one building at all occupied your attention?—No. The only thing that comes to my mind is this: if four cam machines are put up again, then they should be separated, one in each room, and there should be brick traverses between all the rooms.

437. Do you know how this work is carried on in private factories, and the number of men in each house?—I do not know any place, except Chilworth, and even then I cannot say how many men they have there.

438. Do you know of any place where they have as many as eleven people in one house at one time?—No.

439. *Colonel Lloyd.* Do you consider the operation of pressing much more dangerous than the operation of granulating?—I think granulating is very much more dangerous than pressing.

440. What is the pressure put upon the powder in making prisms?—No one can tell you that.

441. *Colonel Majendie.* You had an explosion in the press house some years ago, had you not?—Yes, in 1870.

442. That was not during the operation of pressing, was it?—No, it was in unloading the presses; it was supposed to have been due to a flaw in the plates, caused by some sandholes.

443. Have you ever had an explosion in the granulating house?—No.

444. Do you know what quantity of powder you have made with those machines?—We have turned out 70,000 barrels of the E.X.E. powder.

445. Have you made any other powder than that?—Yes, some 1,500 barrels perhaps.

446. Where do you press your black powder?—We do not press any at all, but we press some brown powder in the moulding house.

447. Are any hand lamps of any description used in this place?—There was one at either end of that building.

448. Were they electric?—Yes.

449. What sort?—Similar to the one sent to you at the Home Office.

450. Had they been altered at all?—No; they were not being used at the time.

451. How do you know that?—Because Bailey told me so. He was the least hurt of any one, and he was quite sensible until within an hour of the time when he died.

452. Was that with reference to the lamp at the north end?—Yes.

453. Did he speak to you about the other lamp?—He said that, as the machines were working, the men would not have any occasion to use the lamps; they would not use a lamp unless they wanted to do something to a screw, and they could not do that while the machines were working.

454. Then the lamps were only for use in an emergency?—Yes.

455. You say the explosion occurred just here in this circle [pointing to the position on the plan where Watts's body was found. Appendix I.]?—Yes. [The witness then again (*see* Question 276) explained, by means of the plan, what Bailey and the boatman were doing at the time of the explosion, and also pointed out where the explosion occurred. He also explained his reasons for believing the explosion occurred at that particular place, and he explained how and in what direction the men moved when they heard the noise].

456. *Colonel Lloyd.* Did the men throw themselves into the river, or were they blown in?—I think they all threw themselves in.

457. *Colonel Majendie.* Were the burning prisms thrown any distance?—Yes, because a man there [pointing to the plan] was hit in the back by one.

458. Was the place scorched at all by the burning prisms?—No; I think it was raining hard.

459. *Colonel Lloyd.* Were the sashes blown out?—Yes, there was glass outside.

460. *Colonel Majendie.* The men get a meal in the night, do they not?—Yes.

461. At what time?—Twelve o'clock.

462. How long are they allowed for that?—Half an hour.

463. Do they all go at once?—Yes.

464. Do they ever bring cups or glasses into the house?—No.

465. *Colonel Lloyd.* Would they change their shoes in going into the dining room?—Yes.

466. *Colonel Majendie.* Have you ever known a case of the men bringing their food into the house?—No, I have never seen any food in the house during the whole course of my experience.

467. *Sir F. Abel.* Is there any possibility of the men smoking in the dining room at night?—No.

468. *Colonel Lloyd.* Would they have access to the dining room at night?—Yes, they could get there, but not without the foreman knowing it.

469. *Colonel Majendie.* Who lit the gas in the dining room?—It is alight all day while the man is there, and he leaves it alight when he goes away at night.

470. Would he light it with a light, or with a match?—He would go to the boiler with a lamp if he wanted a light; but, as a matter of fact, the gas jet is never out, nor is the stove put out.

471. Was there any dust outside the house?—No, there is no dust in this powder at all, it is a very clean house.

472. Were any remains of the barrel Watts was moving found at this part [pointing to the position on the plan where Watts's body was found. Appendix I.]?—No, nothing in the house at all except the timber fallen from the roof.

473. Watts could have got out, could he not?—Yes, he had the best chance of the lot.

474. Supposing anything happened to his powder?—He could not get away then.

475. Had he been accustomed to do this work for some time?—Yes.

476. *Colonel Lloyd.* What proportion of the men are searched at the gate?—I could not tell you; I have nothing at all to do with that.

477. They are not all searched at any rate?—No.

478. Therefore there may be some presumption that a man could get into the factory with matches in his possession?—Yes, but only as far as the shifting room.

479. Are the cam machines made in pairs?—No, they are single machines.

480. There is then no reason why they should not be worked in separate rooms?—No.

481. Would a workman ever alter the fittings of a machine without the assistance of the fitter?—No; the only thing a foreman would do would be to put a plunger right when it got compressed. He has some thin tin liners, and he would put one under it, and that would set the thing right at once.

482. What tool would he use for that purpose?—A spanner.

483. Would any other spanner do instead of a steel spanner?—The Chief Engineer says not; he says the points of other metal spanners would not stand the strain.

484. *Sir F. Abel.* Would there be any temptation to a man to do anything in the way of repairing a machine?—No.

485. *Colonel Lloyd.* In the case of the barrels that have to be moved, full of powder, from one place to another, would there be any objection to providing them with a tighter fitting cover than the canvas cover which is now used?—I think it would be difficult to do that. Originally we had wooden tops to the barrels, but we found that in moving the barrels out of the boats the men sometimes caught hold of the tops of the barrels, and when the tops slipped off, the barrels fell.

486. Are the canvas cloths you now use for putting on the heads of the barrels impregnated with powder dust?—No, they might be if they got wet, but they are constantly changed.

487. *The Chairman.* If anything in the way of an explosion had happened, would not the machines have been destroyed?—I think not, because there are here and there openings in the buildings.

488. *Colonel Majendie.* Is grain quicker than prism?—Yes, it is quicker, but even then it is slow on account of the density.

489. *The Chairman.* Have you, in your own mind, any idea as to the probable cause of the accident?—I think something must have happened to the powder barrel, but what it was I could not say. I got from the injured men all the information I could, and if the Committee would like to hear their statements, I will read them.

490. If you please?—James Bailey, foreman of the cam house, said: "I had only just left the south end, where Nos. 2 and 3 machines are, and which were working all right. Everything appeared correct, and had been so all night. I passed the boatman Watts in front of the water-wheel, trundling a barrel of grain powder, going into the south end; and when I had arrived against No. 5 machine in north end, a rumbling noise was heard, and all the men in this end looked up and exclaimed, 'What's that!' And after a little while another noise was heard, and a flash of fire seen, when we all started to run out of the house. I had got clear of the house before it exploded, but appeared to have been blown in the water while running away. I kept swimming about until rescued. I cannot account for the accident." Bailey was in the water nearly an hour; he died on 19th December, 1893, at 12.45 a.m. James Clayden, one of the men working No. 2 cam press, said: "I was working in front of machine, and saw pressed prisms pushed off all right, and turned to pack prisms on the rack, when a flash came behind me from my machine." Asked if he knew what caused the fire, he said, "No; machine had been working all right." He died, 14th December, 1893, at 2.15 p.m. William Rudkin, the other man working No. 2 cam press, was so severely burned that he died at 2.30 a.m., 14th December, 1893, having been unconscious the whole time. Edward Larman, one of the men working No. 3 cam press, said: "I was working in front of machine, and had just turned to pack the prisms on rack, when a flash of fire came from the direction of Clayden's machine (No. 2)." Asked if anything had happened to Clayden's machine, he said: "Not as far as he knew. When explosion took place, myself and Clayden ran out of house and got into the river where we were found. I cannot account for the explosion." He died 18th December, 1893, at 7.35 a.m. George Rudd, the other man, working No. 3 cam press, was so severely burned that he died 14th December, 1893, at 1.45 p.m. I tried to talk to this man on several occasions, but he was not in a condition to talk to me. Benjamin Hare, one of the boatmen, stated that "they (himself and Watts) had cleared the north end of pressed prisms and taken two barrels of grain in. Watts, the deceased boatman,

who was the only one killed on the spot, was taking a barrel of grain to the south end when the first flash was seen coming from that end. I went to the door of the boat and took off my clean slippers, when I was knocked in the river. I swam about and helped Jennings and Rudd out of the river; we all then walked up to the shifting room."

491. *Colonel Majendie.* With reference to the precautions for the future, I understand you consider it desirable to separate the machines?—I think, if it is intended to work the cam machines again, they should each have a room, the rooms to be separated by brick traverses, and instead of having a boat there should be a tramway line. For small quantities of powder which are being pressed at one time, it is very difficult to get boats up and down.

492. Do you see any reason for the suggestion that other machines should be substituted for the cam machines?—No, I do not.

493. Do you think that the character of the machines is at all affected by this explosion?—No.

494. Have you anything to say in regard to the construction of the building, would you advocate for the future a like construction to this?—Yes, only a little more room in it.

495. *Colonel Lloyd.* With separate machines in separate houses, what would be the maximum quantity of powder that would blow up in any one house?—Seeing that the hopper must hold 40 lbs. of powder, I think you could not do with less than 100 lbs. in each house.

496. *Colonel Majendie.* With such a quantity as that it would be rather in the nature of a mill accident than of an explosion, would it not?—Yes, certainly. After what has just happened, I think such buildings as these will not be put up again. We naturally thought the place was safe, because we have done this work so long; I think the old building is quite 100 years old.

497. *The Chairman.* Is there anything else which you wish to say in reference to this accident?—I should like to be allowed, if I may, to say a word in reference to the evidence given at the inquest by Mumford and Wraighte. What they said was simply perjury and falsehood, and, in my opinion, they are very dangerous men to have in a powder factory; I do not think they ought to stay there, because if they are bad enough to do one thing, they are bad enough to do another.

498. *Sir F. Abel.* To what particular portion of their evidence do you refer?—Mumford said the pins were so hot that he could not put his hands upon them; I have never heard of such a thing in all my life. The whole of their evidence was merely a pot-house arrangement, and it is not safe to have such men about the place.

499. *Colonel Majendie.* Is not that rather a matter for the Superintendent?—I have told him that those men ought not to be in a powder factory. One of them said he had been reduced in wages on account of the evidence he had previously given, but that was not true; he also said that he had been punished by having to eat his dinner half frozen, but the dining room was within 60 yards of his working place, where he could have gone with the other men.

(*The Witness withdrew.*)

SATURDAY, 27TH JANUARY, 1894.

Present.

Lord SANDHURST, *Chairman.*

Members.

Sir F. A. ABEL, Bart., F.R.S.
Colonel V. D. MAJENDIE, C.B., Her Majesty's Chief Inspector of Explosives.
Colonel F. T. LLOYD, C.B., R.A.

Mr. R. H. BRADE, *Secretary.*

Colonel M. T. SALE, C.M.G., Superintendent, Building Works Department, and Captain H. HULEATT, R.E., Second Assistant, Building Works Department, *examined.*

500. *The Chairman.* You are Officers serving under the Director-General of the Ordnance Factories, I believe?—Yes.

501. (To Colonel Sale.) Has your department to do with Waltham Abbey as well as with Woolwich?—Yes, we have to do with the structural works at Woolwich, Waltham Abbey, Enfield, Birmingham, and part of Weedon.

502. *Colonel Majendie.* Do you know the building at Waltham Abbey where the late accident happened?—Yes.

503. Was that building erected before you were appointed to your present position?—Judging from the plans and documents in our possession, it appears to have been erected in 1846 or 1847.

504. From what you know of the place, has it been in any way modified?—Originally it was an incorporating mill; it was blown up in 1861, and reconstructed in the same year as an incorporating mill; in 1887–88 it was converted into a cam house.

505. Was the structure modified in 1887–88?—It was lined throughout with match-boarding, and all the necessary precautions were taken as customary.

506. Will you state in detail the structure of the

house?—Here are the original plans, up to the time of its being made into a cam house [handing in and explaining the same]. The walls were all of wood, with the exception of the cross walls; but the brick wall now standing *there* (*i.e.*, at the south end of the house) was built afterwards, *i.e.*, in 1861.

507. What was the roof?—It was a boarded roof, over timber rafters, covered with tarred felt.

508. Was the interior of match-boarding throughout at the time of the accident?—Yes, with copper fastenings.

509. Was there any exposed iron in the structure?—No. There was a wooden floor, with the usual leather covering, the hides being fastened with copper nails.

510. Was the electric light entirely outside?—Yes; formerly they had wooden insulators, but afterwards earthenware insulators were put in.

511. Was the house, so far as you know, a satisfactory house?—Yes, it was perfectly sound.

512. Have you seen a screw which was found in one of the machines after the explosion?—I have heard of it, but I have not seen it.

513. (To Captain Hulcatt.) Have you seen that screw?—Yes.

514. Are you able to identify it?—Yes, it came from the outside part somewhere.

515. Then it could not have fallen into the press until the roof had been destroyed?—That is so. When the building was put up, in 1847, they used iron fastenings, but that is not the practice now.

516. Is it the case that there were other screws of the same character found after the accident?—Yes.

517. All of which came, I presume, from the same source, the roof?—Yes, we found one on the upper side of one of the tie beams, but that would be outside the match lining.

518. Would you say that there was nothing in the roof which could reasonably have been able to fall into the press?—No.

519. How are the roof boards inside fastened?—By copper nails.

520. (To Colonel Sale.) Are those copper nails at all liable to loosen and fall?—No, I have never heard of such a thing.

521. Have you considered the structure of the house since the accident, is there anything which should have been modified in order to prevent an accident of this kind?—The only thing that I can conceive possible, in the case of a wooden structure, is that owing to the chinks in the walls the dust from the outside may have effected a lodgment during the tempest that prevailed on the night of the explosion; but that is only a bare possibility.

522. When you have taken these houses to pieces from time to time, have you found that sort of thing between the lining and the wall?—Not to my knowledge.

523. (To Captain Huleatt.) Has such a thing come before you?—I have heard of powder dust working under the hides, but I cannot say in what house that happened.

524. Have you heard of any grit working into a house between the wall and the lining?—Yes, but probably that came from the wall.

525. But taking a wooden wall, that has not been actually found?—No, not to my knowledge.

526. A match-boarded house interposes two barriers to the grit in the wall?—Yes, match boarding inside, and weather boarding outside.

527. With regard to the house itself, I understand the wall at the south end is standing?—Yes.

528. Will it have to be reconstructed?—No.

529. In all other respects I understand the house was destroyed?—It was burned, and we had to pull it down afterwards.

530. Was there any explosive effect produced upon the foundations of the house?—I believe it was thought that there was a slight depression somewhere *here* [indicating the spot on the plan, about where Watts's body was found, *see* Appendix I.], but I could not see anything: the walls appear to be quite sound.

531. (To Colonel Sale.) Do you concur in that opinion?—Yes, the walls appear to me to be quite sound.

532. (To Captain Huleatt.) Are any of the other houses in the factory affected at all?—No.

533. Even to the extent of broken windows?—No, it was a very slight explosion, and even the trees near have not been much affected.

534. What was this passage covered with?—Felt.

535. Was that felt blown about at all while the fire was burning?—I was not there myself at that time, but I was told that it was blown about while the fire was burning.

536. (To Colonel Sale.) Are you favourable to this use of felt?—I should not put felt on a new construction.

537. If an explosion occurs, is there a reasonable fear of the felt becoming ignited, and being blown about, and injuring other buildings?—It would require a combination of all three effects, explosion of a very special sort, fire and wind, to do that. I think an ordinary explosion would not set fire to felt in the way it was set fire to in this accident.

538. What construction would you recommend?—Sheet zinc over boarding; it is better and more satisfactory from a structural point of view.

539. *Sir F. Abel.* (To Captain Huleatt.) Was there not one peculiar feature about this house, namely, that there was a considerable step up from the platform to the floor?—There was a small step from one platform to the other, but I cannot say about a step into the building itself.

540. *Colonel Majendie.* (To Colonel Sale.) Can you supply us with a plan of the house as it existed at the time of the explosion?—Yes, here is one [handing in the same, *see* Appendix I.].

541. *Colonel Lloyd.* (To Captain Huleatt.) The corridor passage outside this house is a closed one, I believe?—Yes.

542. What was it composed of?—Generally speaking, it was the same structure as the rest of the house; it certainly was copper-nailed, because I have just lately repaired it.

543. Was it covered with hides?—No, I think not.

544. There were no hides on the corridor?—No, I think not; I think the whole thing was clean to the boat.

545. (To Colonel Sale.) Was it match boarded as well as weather boarded?—It was not match boarded.

(*The Witness withdrew.*)

Captain F. L. Nathan, R.A., *examined.*

546. *The Chairman.* You are the Officer in charge of the danger buildings in the Royal Gunpowder Factory at Waltham Abbey, I believe?—Yes.

547. What are your duties?—I assist generally the Superintendent in the management and working of the factory.

548. Are you intimate with all these buildings?—Yes.

549. How long have you held your present appointment?—Since October, 1892.

550. *Colonel Majendie.* Were you in your house at the time of the accident?—Yes.

551. How soon afterwards were you on the spot where the accident happened?—I got there about 5 minutes to 3, the accident having occurred about 20 minutes before.

552. Was there anything in the nature of an explosion after you arrived there?—There was one little pop, but nothing much.

553. When you got there, was this house fully alight and blazing?—Yes.

554. Had the injured men been recovered at that time?—Most of them had.

555. Did you see the man Watts at all?—Not until I saw him at the mortuary.

556. You do not know of your own knowledge where he was found?—No.

557. There was a little passage leading from the house, and then there was a little platform. Was this close boarded, or was it battened?—The boards ran lengthways with very small intervals. It was laid like all platforms—9-inch boards, with little openings of perhaps $\frac{1}{8}$ inch between them.

558. Were the boards placed longitudinally?—I think they were crossways.

559. Was the floor of this house higher than the platform?—Yes.

560. How much higher?—About 6 inches.

561. Therefore, a man conveying a barrel along here to the house would have to raise it?—Yes, he would have to lift the barrel from the well to the floor of the house.

562. Have you seen the men bringing barrels along here?—Yes.

563. How do they do it?—They trundle them along until they get *there* (*see* Appendix I.), and then they lift the barrels to *that* part (*see* spot marked B^1 on the plan in Appendix I.) and then they trundle them along to the machines.

564. Was there any evidence as to an explosion of powder, or evidence of any action of powder at *that* part (*i.e.*, the spot where Watts's body was found, *see* Appendix I.)?—When I examined the house it had suffered very much from fire, and all the flooring had gone completely from there. There is a gap between the wall and the brick pier on which the joists laid; I had not looked for any explosive effects there, but when you came down and suggested that the burnt débris that was there should be removed in order to see what was underneath, I had your suggestion carried out, but there was nothing at that spot which I could say had been caused by an explosion of powder.

565. *Sir F. Abel.* Have you ever seen any considerable quantity of E.X.E. powder exploded?—No.

566. *Colonel Majendie.* Were any portions of the barrel found?—I do not know.

567. Having regard to what you saw after the accident, would you say there had been a formidable explosion, or would you say that it was chiefly in the nature of a fire?—A very intense fire; the whole house was burnt.

568. Have you, from a mechanical point of view, made a special study of the machines?—No, but I have seen them working constantly.

569. Who is your engineer at Waltham Abbey?—Mr. Hodgson. He is called the chief engineer, a position corresponding to that of foreman millwright in the Arsenal.

570. Is he very familiar with the machines?—Yes.

571. Has he taken them to pieces?—They have been taken to pieces by the mechanic who had charge of them while running.

572. With regard to the general working of the place, how far do your duties require you to have a knowledge of that; did you go often to this building?—Yes, very frequently.

573. Is it part of your duty to go round the buildings from time to time, to see that the work is being properly carried on?—Yes.

574. Is it part of your duty to see that the men have proper clothing on?—Yes.

575. As a matter of fact, do you yourself ever search the men, or require them to open their outer clothing, in order to see that there are no pockets in the inner clothing?—I have done so once or twice.

576. Did you, on any occasion, ever find them improperly dressed?—No.

577. Did you find any iron fastenings on their clothes?—No. The foreman of each house examines them, and reports to the chief foreman of gunpowder or to his assistant, who goes round every day.

578. Are they required to visit every house?—Yes.

579. Do they make a written report?—Yes, but anything incorrect would be reported at once.

580. Are those reports filed?—Yes, and they come to me.

581. Have you seen these particular men who were injured at work?—Yes.

582. How about the night work? Would there be the same amount of observation and supervision at night as there is in the day time?—Hardly that, because there are not so many people about, but there is a foreman in charge of the house.

583. Do you sometimes go round at night?—Yes, I was round at that house within a month of the accident, but I never found anything wrong there.

584. Were those same men always on at night?—No, they had one week night work and one week day work.

585. Have any complaints ever been made to you about the imperfect working of the machines, or of anything hazardous in the working of them?—No.

586. Do you think that anything about the machines was dangerous?—No.

587. *Sir F. Abel.* Have you been led to suppose that there was anything in this particular accident which had to do with the breaking of the plungers?—They often broke, I think.

588. *Colonel Majendie.* Is there any chance of the bearings becoming heated, or is there a good lubricating arrangement?—Yes, so far as I know they were always working properly when I saw them.

589. *Sir F. Abel.* Whose duty was it to see that they were properly working?—The duty of the engineer.

590. *Colonel Majendie.* What orders were there with regard to repairing the machinery; supposing you found one of the men engaged in repairing the machines would you have at once understood that he was doing what he ought to do?—He should not certainly repair a machine; the only thing a man should do, with the foreman assisting, would be to pack up the plungers; plungers are liable to set up slightly and make big prisms; the men would then pack up the plunger by putting in a small piece of packing.

591. *Sir F. Abel.* Would they leave the mechanic to do that?—I am not quite certain about that, but they would, if necessary, pack up a plunger at night certainly; in the day time they might or might not do it. I do not think anything of that sort was going on at the time of the accident because all the machines were running, and they could not do anything of the kind while they were so running.

592. *Colonel Majendie.* I understood there were two electric hand lamps in the building?—Yes.

593. What lamps were they?—The Pitkin lamp.

594. Has the suggested alteration in regard to them been carried out?—Yes.

595. Were those lamps in use at the time of the accident?—I think it is most improbable; they would be used only by the foreman, and he told Mr. Findlay, before he died, that the machines were all working.

596. We understand those lamps were not used for illuminating the building, but only to enable them to light up some part of the machinery?—That is so.

597. Here are some rules which have been handed in as applicable to cam houses, can you throw any light upon them? For instance, Rule 2 says, "Great care must be taken to prevent any undue straining of the machine, as a neglect of proper precautions has led to serious accident"?—That means breaking plungers.

598. Would they call that a "serious accident" if a plunger breaks every day?—I cannot say.

599. Who drew up these rules?—General Noble, I think, but I am not responsible for them.

600. What does this mean: "It is most important that no grain beyond the proper quantity is in the 'bouches' when a pressing is commenced"; why is that, to prevent any increased density?—That probably refers to the charger, as it might mean putting in too large a charge.

601. Does it relate to any possible danger?—No, only to an undue strain that might be put upon the machine.

602. Are we to take it that the quantity in the cam house for each machine must never exceed 200 lbs., and that that relates to powder in any form, prisms or grains?—Yes.

603. And that "no gunpowder is to be kept in the house when not at work"?—Yes.

604. *Sir F. Abel.* "If there be any suspicion of undue straining due to any cause, the machine should be stopped," what does that mean; is it not possible that a man employed there might not know what "undue straining" was?—I think that refers merely to the machines getting dirty.

605. It is a regular practice, not merely an occasional practice, to wash out the machines at a particular period, is it not?—Yes, it depends upon how the machine is working, and the state of the pins.

606. Was the system of washing introduced since these regulations were drawn up?—It has always been the practice; I do not see how they can possibly work the machines unless they are washed out.

607. *Colonel Majendie.* Here is another thing which is rather uncertain, "No person, except those who are properly instructed and duly authorised, is at any time to meddle or interfere with the machinery," does that mean taking the machinery to pieces, or does it only refer to repairs?—I think it covers anything dealing with the machines.

608. *Sir F. Abel.* "Duly authorised"—would the ordinary workman consider himself "duly authorised"?—No, not unless he was working under the foreman, the ordinary man would not be allowed to touch the machines except under the foreman's orders.

609. *Colonel Majendie.* Was the mechanic here when these orders were drawn up?—I could not say.

610. I presume, as Danger Officer, your duty is to enforce these rules?—Yes.

611. Have you had any cases since you have been there of men being reported for smoking?—No.

612. Have you any reason to believe that anything of the sort goes on either night or day?—No.

613. There has been no case of men smoking in the shifting house, for instance?—No.

614. In the General Rules, it says: "Trousers of working dress are not to be turned up, as small stones and particles of grit are likely to be carried into the houses thereby," is that strictly enforced?—Yes.

615. Does that rule apply to the under trousers, as well as to the "lasting" trousers?—Yes.

616. It would be equally dangerous?—Yes.

617. I understand from you that pockets are prohibited in any part of the clothing whatever?—Yes.

618. *Sir F. Abel.* In No. 7 of the General Rules, it says: "The police have orders to search and examine from time to time persons taking anything in or out of the gates"—there is nothing said there about searching men personally?—They have orders to do it; the police do search a percentage.

619. *Colonel Majendie.* What is the percentage?—I think during the week they search about half the men of the factory, and they report having done so.

620. Do you rely upon that searching for the exclusion of matches?—Mostly upon the exclusion of pockets, and upon the knowledge that if they have matches they will be discharged. If a man tells a policeman he has no matches, and then the policeman finds some on him, the man is reported and discharged at once.

621. *Sir F. Abel.* With reference to the men who have been discharged since the accident, were any of them discharged not by the searching of the police, but by the foreman?—No.

622. The police examine only a percentage?—Yes, as the men come in in their ordinary clothes, whereas the foremen have to examine every man in his working clothes.

623. Then the matches might be in a man's clothes in the shifting room?—That is so.

624. *Colonel Majendie.* When they leave the shifting room, is there any barrier for the men to pass through?—No.

625. *The Chairman.* Do the men assist you in keeping this rule; do they ever report their colleagues for carelessness?—No; but I think if one man caught another smoking, he would report him for it. It might be possible in a small house, where there were, say, only two of them, to make some arrangement between themselves as to smoking, but in a house like that, where there were eight of them, under an old foreman, I do not think such a thing would have been done, eight men would not wink at another one smoking.

626. *Colonel Majendie.* No. 15 of the General Rules says: "Open powder barrels and charge tubs are always to be rolled on their chines, and never dragged along the platforms, or the floors of houses or boats." You have seen men frequently bringing in the barrels, is that the way they work them in?—Yes, in all the houses.

627. Have you ever seen them drag them in?—No.

628. Would there be risk, in your judgment, if they dragged the powder?—Yes, if there were particles of grit on the platform.

629. With an open platform I suppose it is impossible to avoid grit in dry weather?—I think so, there is always a liability to that; but the platforms are always kept wet, and they were very wet that night.

630. Would it be wet inside the house?—No, but frequently it was very damp, because of the water wheels.

631. Were you satisfied with the construction of the house, or was there anything in it which you thought dangerous?—I think the house was satisfactory, it was match lined inside.

632. Was the match lining in good order?—Yes, there was an exit door behind every man, and I am surprised they did not all get out.

633. *The Chairman.* Which way do those doors open?—Outwards.

634. How are they fastened in case of wind?—By a rope and counterweight.

635. Were they ever locked at all?—No.

636. *Colonel Majendie.* Could you say whether these doors were secured in any way on that night?—I think not.

637. *Colonel Lloyd.* Have you any special personal knowledge of the effect of drawing a very heavy weight, like a barrel of gunpowder, over a surface where there is a certain amount of powder dust?—I have never seen that.

638. Would the effect of such a heavy weight being drawn over powder strewn upon the surface be sufficient to fire it?—I think decidedly not.

639. I am speaking of powder in a very fine state?—I think that would make no difference.

640. Then can you explain why this rule about dragging along the floors was introduced?—Because if there were grit present then it would be dangerous.

641. It would be more dangerous to break this rule if you had a mixture of powder and grit?—Yes, I think so.

642. Have you any knowledge of the effect of a blow upon very fine powder dust?—No.

643. Could you say whether it would be liable to be ignited?—It would depend upon what the circumstances were.

644. Say wood upon wood?—No, I think not.

645. Was the step going up into the cam house covered with hide?—Yes, the hide was lapped over,

646. Was the leather covering of the floor entirely destroyed by the fire?—Yes.

647. With reference to searching men at the gate, are pipes and tobacco allowed to be brought into the factory?—No, pipes would be the same as matches, but the men are allowed to have tobacco to chew.

648. Pipes are not mentioned in the rules?—No, those rules were draw up by our predecessors and we have not altered them, but after our experience I think they are not quite what they should be.

649. *The Chairman.* I suppose it would be easier to roll a barrel than to pull it?—Yes.

650. So that it would be only the natural instinct of a man to roll it?—Yes.

651. *Colonel Lloyd.* It is quite possible in hoisting a barrel from the well to the floor of the house that there should be a blow or a certain amount of friction?—Yes.

652. *Colonel Majendie.* It would not be rolled up?—No, they had to get both hands and make a clean lift of it.

653. *Colonel Lloyd.* And in doing so a man might drop it on to the edge of the step?—Yes, but even then it would only be wood on leather.

654. *The Chairman.* Do you take men into the works without a character of some kind?—No, we always know something about them; of course the men are shifted about from one job to another.

655. But you are particular about putting certain men to certain jobs, are you not?—Yes, as a rule they are employed first of all as boatmen and afterwards they are shifted. Only reliable men are employed in the granulating house for instance.

656. *Sir F. Abel.* Have you formed any opinion in your own mind as to a possible cause of the accident?—No, I see no evidence upon which to arrive at a probably distinct cause; of course the lifting of a barrel of powder is a possible cause, but one cannot say for certain.

657. *Colonel Majendie.* Have you been able to form any confident opinion as to where the accident originated?—No, except that it originated in this house.

658. You cannot go any nearer than saying it was in the south part of the building?—No, that is according to the statements of the men about at the time.

659. Have you been able to form an opinion as to what portion of that house it was likely to have originated in?—No, but Clayden's statement that a flash came from his machine and from behind him, would, I think, tend to indicate that it came from his part of the house.

660. When men come in first what steps are taken to inform them as to the rules?—The rules are read over to them when they are engaged, and the rules of their particular house are read over to them by the foreman, I think, once a week. Of course the rules are posted up in the houses.

661. We understand that the men in the cam house would be required to observe two sets of rules?—Yes.

662. Are the general rules posted up in that house?—No.

663. Have the men a book of them in any form in their possession?—I think not, I think the book of rules was discontinued about the time the Ordnance Factory rules were introduced.

664. What are the Ordnance Factory rules?—They are rules which are generally applicable to all factories.

665. Not general danger rules?—No.

666. Did those general rules relate principally to accidents?—Yes.

667. How are the men kept informed about these Waltham rules; do you suppose the men occupy much of their time in reading them?—No.

668. Can they all read?—I cannot say.

669. You have paid some attention to the electric light in danger buildings, have you not?—That I have nothing to say to.

670. But if in your judgment it was dangerous, you would have something to say to it, would you not?—We can only make suggestions as to altering it.

671. Is there, in your own knowledge, anything with regard to the electric light which was suspicious or dangerous?—No, because that house was re-wired on an improved system; I considered the installations satisfactory.

672. Then you would hardly include the electric light as one of the probable causes of the accident?—No; anything going wrong with the light would put the whole house in darkness, and I understand from what the men said before they died that there was plenty of light in the house.

673. Were there any utensils in the house made of glazed earthenware?—No.

674. Do you remember where the vessel was in which they deposited their oiled sponge clothes?—It was outside, and well clear of the building.

675. You were fully alive to that risk, and any departure from the regulations upon that point would be treated accordingly?—Yes.

676. I observe there is nothing in the rules about that?—No, but I have known of so many accidents in regard to them that I am particularly alive to the danger.

677. *Sir F. Abel.* The steel spanner of which we have heard a good deal was always lying about, was it not?—It was supposed to be kept in a cupboard in the shoe room.

678. As a matter of fact, we saw it lying on a bench or table in the house?—That was there for your inspection.

679. It was not supposed to be kept there so as to be available for the men?—No it was only to be used by the foreman or under his direction, and not generally

680. *Colonel Majendie.* Are you aware that any representations have been made with regard to this particular house, which have not been acted upon?—No.

681. Did you see Watts after his death?—Yes.

682. Was he injured by explosion as well as by fire?—As far as I could see I think his head showed some signs of being partly blown, but he was so very much charred.

683. None of the others were injured in that way, I believe?—No, the worst burns were probably caused by the prisms sticking on and burning.

684. With regard to the future, would you desire to see this arrangement reproduced, or some modification of it?—I think it would be desirable to isolate each machine, and to limit the number of persons.

685. What sort of number would you propose for each compartment; would two persons be enough?—Yes, *plus* the foreman.

686. There is always the man who serves the house coming and going?—Yes.

687. That would make four as the maximum in a compartment in any one time?—Yes.

688. Do you think you could work with that arrangement?—Yes, decidedly.

689. Do you think it would be easy, having regard to the character of this accident, and the non-explosive nature of the prisms and the stuff generally, to so isolate them that an accident, if it happened, would be reasonably confined to one compartment?—Yes.

690. Would you treat the building to some extent like an incorporating mill?—Yes.

691. *Sir F. Abel.* Would there be much accumulation of dust during this process?—No.

692. Was there any dust outside?—No.

693. Would you propose that there should be a similar free communication between the houses, that is with reference to the covered way?—No, I should bring a tram alongside and have a platform to each house, the brick wall projecting beyond the side walls of the houses.

694. *Colonel Majendie.* What are your particular reasons for a tram?—I like it, as I think for this particular class of house you can get the work better done. I do not think we could work a granulating, or a

dusting house with a tram because the quantities are so large, but I think you could work a cam house by that means, and also a moulding house. If you deal with small quantities, as in this case, then I think a tram is a good communication.

695. Is 200 lbs. the lowest limit for each machine?—I think you could work with less for a tram, it might be reduced to even a barrel.

696. The night of the accident was a stormy night, was there any lightning?—I did not observe any.

697. Was there a conductor on the house?—Yes. When I got down there on the morning of the accident I saw the Superintendent, and he told me to go at once and look after the injured men, and so I saw very little of what was going on.

698. *The Chairman.* Do you agree with others that the operation in which those men were engaged is not a very dangerous one?—We never regard it as dangerous; it is not to be compared with the granulating and the breaking-down work.

(*The Witness withdrew.*)

Mr. SKINNER, *examined.*

699. *The Chairman.* You are engaged in the powder factory, at Waltham Abbey, I believe?—Yes.

700. You were one of the gang at work in this cam house at the time of the explosion, were you not?—Yes.

701. And the only one of them uninjured?—Yes.

702. How long have you been working in the factory?—Between six and seven years.

703. *Colonel Majendie.* Have you been working for the whole of that time in the cam house?—No, only for 18 months in the cam house.

704. At the time of the accident where were you?—Here [pointing to the plan, *see* Appendix I.; the witness also showed where Bailey, Jennings, and Massey were].

705. Had you been in the other compartment at all?—Not since supper.

706. What time was that?—11 o'clock.

707. Where do you take your supper?—Sometimes in the shoe hole there, or in the dining room.

708. Where did you have your supper that night?—In the shoe hole.

709. Who else had it there?—Almost all of us.

710. *The Chairman.* How does the supper get there, is it brought from the dining room?—No, we bring it from our own homes.

711. *Colonel Majendie.* Is the supper heated in any way?—Not unless you take it from the dining room.

712. Is there any cooking required?—No.

713. Do you have any hot tea?—Yes.

714. Where do you make that?—In the dining room.

715. Was it cold or hot at the time of your supper?—Cold.

716. You did not bring any kettle from the dining room and make the tea there?—No.

717. Is that ever done?—No.

718. Did you all knock off work for a definite time?—Yes, when the light goes out, when they oil the engines.

719. At the time of the accident you were where you are shown on the plan?—Yes.

720. What did you first hear or see?—I heard a report in the other end.

721. You are sure it was from *here* [pointing to the south end of the house as shown on the plan, *see* Appendix I.]?—Yes.

722. Was it loud?—Yes, something like a 7-pr. when fired.

723. Did you guess what it was?—Yes, we guessed there was something up by the flash.

724. What did you do?—I went straight for this door, and got out as soon as I could. I heard a second explosion before I got out.

725. Did you hear any more reports?—Yes, when I got by the trees the whole thing seemed to go at once; I heard, however, no more than a rumbling noise, because I was so near to it.

726. Did any of the other men get out at the same time as yourself?—I never saw anyone.

727. When did you next see any of your mates?—I came up as far as the water warder's house and told him our house was gone, that was about 30 yards from the building. As I was turning round I saw Carr coming along as best he could with his clothes on fire, I got some water and put him out. Afterwards I saw Massey.

728. Did you see Jennings?—No, I did not.

729. Did you see Bailey?—No.

730. Did you see the other men who had been there?—Only after they had been removed.

731. Did you see Watts?—No, I never saw him at all.

732. When they bring the barrels they bring them up *here* [pointing to the clean platform as shown on the plan, *see* Appendix I.], do they not?—Yes.

733. How do they bring them?—They roll them on the chine.

734. Is the floor of the house a little higher than the platform?—Yes, there is a step.

735. How did they get the barrel up the step?—They lift it up.

736. Is it hard work for a man to do that?—Not very, it is only a little lift.

737. Having got it in the house what do they do then?—Place it behind a machine, one to each machine.

738. Do they roll it there?—Yes.

739. Did you ever see them drag it?—No, never, it would be harder work.

740. Is it hard to move a barrel on to its side before they begin to roll it?—No, you can tilt it very easily.

741. Have you ever worked in this other part?—Yes.

742. Is the process just the same as in this part?—Yes, only they have to roll it on the chine past the water-wheel.

743. In working in this house did you always wear clean shoes?—Yes.

744. Where did you put on those clean shoes?—In the house *here* [pointing to shoe-room marked in the plan].

745. Were all the men, so far as you know, dressed in the proper clothing that night?—Yes.

746. Had you been working in this house before supper?—No, I only went to get my supper and I had to pass through that house to do so.

747. Did you see these men at work that night?—Yes, I believe I did once.

748. Did you talk to them while they were having their supper?—Yes.

749. Were they, so far as you could judge, sober, and right in all respects?—Yes.

750. Had you got your proper clothes, the lasting clothes, over your other clothes that night?—Yes.

751. So far as you saw, were the other men dressed in the same way?—Yes

752. When you go into the factory, you are first of all searched, or liable to be searched, by the police, are you not?—Yes.

753. Then you pass through the gates into the shifting house?—Yes.

754. What happens there?—We strip everything off, and put on our other clothes.

755. Are those other clothes, clothes with pockets sewn up or cut out?—Yes.

756. Who sees that you change in the shifting room?—Nobody; but the foreman has his rules to look at any man if he thinks proper.

757. Are you prepared to say that he looks at every man every day?—No, he does not.

758. You say that when men come to work the rules are read over to them?—Yes, a man is told everything before he comes, and they see him afterwards.

759. Have you ever been introduced to these rules at all [the witness was shown a copy of the cam-house rules]?—Yes.

760. Had you ever seen the general rules, have you a book with them in?—Yes.

761. When did you get that book?—About 12 or 18 months ago.

762. Has every man, so far as you know, a book?—Yes.

763. Have you ever had these rules read over to you?—I do not say that I have; they are posted up at the gates as you enter the works.

764. What do the books contain, do they contain these rules, and the rules of all the houses?—No, every man knows his own rules, and the general rules are posted up all over the factory

765. Have you ever stopped to read them?—Yes, there are some posted up near the gate, and as we are waiting to go in we read them.

766. Are there any men who cannot read?—Yes.

767. Do they have the rules read to them from time to time?—Yes.

768. I presume all men know it is against the rules to smoke?—Yes.

769. Have you ever seen that done?—No, and if I had ever seen anybody doing such a thing, I should have reported him at once.

770. Even in the shifting house?—Yes.

771. Do you think the rule with regard to pockets is strictly observed?—Yes.

772. The rule is to have the pockets either sewn up or cut out?—Yes, you must do one or the other, we do not want pockets as we have nothing to carry about with us.

773. Have you ever seen men with matches in their possession in the factory?—No.

774. Have you known the machines do anything which you considered dangerous?—I have known the charges to become very troublesome when they got worn; that is caused by the plungers meeting, and when it happens the machines get damaged.

775. When a machine behaves in that way, what happens, what do you do?—I pull a lever out and stop the machine, the foreman comes and sees to it, and sees that all is right again before the lever is put in.

776. When that happens do they remove all the powder that is in the house?—Yes, if they are going to do anything in the way of screwing up bolts and things of that sort.

777. What does a man use for doing that?—A spanner.

778. Where is that kept, in the house?—No, in the shoe hole.

779. Is that spanner ever used by anybody except the mechanic?—Yes, if the bolts were working loose during the night we should screw them up, or the foreman would.

780. *Sir F. Abel.* Would you do it of your own accord?—No, not unless the foreman told me.

781. *Colonel Majendie.* Have you ever done it yourself?—Yes.

782. In that case the machine is not cleared of powder?—No, because it may be only the nut working loose.

783. Were the machines all working at the time of the explosion?—Yes, all four.

784. You can speak of these two, but how can you tell about the other two?—Because there is a tell-tale, so that we should not put in with the other machines.

785. What is the object of that?—So that there should not be too much strain on the wheel at any one time, and so that as near as possible we should all be pressing differently.

786. Then you know absolutely whether the machines are all working or not?—Yes.

787. And they were all working at the time of the explosion?—That is so.

788. Are the machines ever repaired while still moving?—No, you cannot do that.

789. Bailey was in the habit of using a little hand electric lamp, was he not?—Yes.

790. Was he using it at that time?—No; he was gauging the prisms at the table by me and talking to me.

791. Would that require a lamp?—No, because there were windows there with the electric light.

792. Was the house dusty with powder?—It would be dusty.

793. But, I presume, not so dusty as a granulating house?—No; we sweep up when we stop for supper, and again before leaving.

794. You did not require your respirator as in the granulating house?—No.

795. Then the dust was not floating in the air?—No, but there was dust about the machines, and we swept that up with a hand-brush.

796. When did you have the powder brought in last?—About ten minutes before the accident.

797. Who brought it in?—Watts and the other man.

798. Where they in their proper dress?—Yes, I think so.

799. Would they take their shoes off?—No.

800. The platform was clean?—Yes, they left their shoes in the front part of the boat.

801. Do you know at all where the spanner was that night?—I cannot say, I did not see it.

802. *Sir F. Abel.* Was there only one spanner for the four machines?—I think there are two in each end, a small one and a big one.

803. *Colonel Majendie.* Were there any tools connected with the working of the machines?—No, only one spanner for each machine in case it ran hot.

804. *Sir F. Abel.* Would they be steel spanners?—Yes, I should say they were.

805. And they were often there?—Yes.

806. Did the pins often run hot?—Yes, they always ran warm.

807. How warm; could you bear your hand upon them?—Yes.

808. Did they often break?—I never saw them break, but the plungers did.

809. Often?—We have had two break in one night, and perhaps two in one day, and then we might go a long time without any breaking.

810. What caused them to break?—The pressure on them.

811. Do you consider there was any risk in that?—No.

812. When they broke, did you stop the machine?—Yes, and it was reported to the foreman in the morning.

813. Would the powder be removed before the plunger was removed?—Yes. Sometimes the pins got warm, and then they bent.

814. *Colonel Majendie.* Have you ever known a pin so hot that you could not touch it?—No.

815. Are there any other defects about the machines besides those you have spoken of?—Yes, I have heard that the nuts which screw the bed of the machine have broken in two, but I have not seen it done. [The witness described the position of the nuts.]

816. One of the cam house rules is, "Great care must be taken to prevent any undue straining of the machine, as a neglect of proper precautions has led to serious accident." What do you understand that to mean?—That is to always look after a machine.

817. What part would be liable to strain?—I thin if the pins were not properly cleared when you started a machine that would cause a strain.

818. What serious accidents have you known?—I have known a machine to be broken up and taken a week to repair.

819. Then do you think the rule means that sort of an accident and not an accident such as an explosion?—That is so, but even that might lead to a serious accident.

820. Here is another rule from the cam house rules, "It is most important that no grain beyond the proper quantity is in the bouches when a pressing is commenced," how do you know what the "proper quantity" is?—The charge shows that.

821. Can you prevent it?—Yes, we stop the machines.

822. Does that often happen?—No, not very often.

823. It says 200 lbs. for each machine, was that regulation observed?—Always, we had a very strict foreman.

824. That 200 lbs. includes prisms, as well, does it not?—Yes.

825. Another rule says, "No persons except those who are properly instructed and duly authorised are at any time to meddle or interfere with the machinery," but if the foreman tells you to do it, you do it?—Yes.

826. And under those circumstances you would be a "duly authorised" person?—Yes.

827. But you would not meddle with a machine unless the foreman told you?—That is so.

828. But if the foreman were in the other part of the house, what would happen?—We should go round and fetch him.

829. Would you stop the machine before calling the foreman?—Yes.

830. Had anything gone wrong that night with your machine?—Nothing that I know of.

831. Had anything gone wrong in the south end?—I think they had packed a plunger on No. 2 machine by putting in a little disc.

832. When did they do that?—Some time after supper, I think.

833. What makes you think that happened?—Because I saw the foreman come and fetch one of the washers.

834. Where did he keep them?—They were hung up beside each machine, and if he had not one at one end he went to the other for it.

835. What are they made of?—Copper.

836. Is that often done?—Yes. When the plungers are put on new they are bound to press the washers down.

837. Had those plungers been put on new?—Yes.

838. When you were in the place the last time before supper, was No. 2 machine working?—They were washing it out, and Bailey was with them.

839. In the general rules, it says: "Trousers of working dress are not to be turned up, as small stones and particles of grit are likely to be carried into the houses thereby." I presume you are familiar with that?—Yes.

840. Does that apply to the trousers you wear under the lasting trousers?—It applies to all trousers, if you have them too long, you must cut the bottoms off.

841. But you would not turn up the bottoms of the trousers you wore under the regulation trousers, would you?—No, because they would fit you before you put them on.

842. As a matter of practice, do the men, to any extent, look after one another; I mean, if you saw a man doing something which you thought was dangerous, would you report him?—Yes, because he would be endangering my life.

843. Has that been done from time to time?—Yes.

844. The other men would not try to screen a man, they would tell the foreman, would they not?—Yes, certainly.

845. Did you notice any lightning on the night of the accident?—I did not see any. When I came out on to the platform there was no wind at all; it got up after the explosion took place.

846. Do you know whether any man had gone from here to the cook-house and back again at supper time?—I do not; I do not think they had. Some one has always to bring hot water to this house in order to wash the machines.

847. Who does that?—The boatman.

848. Where does he get the hot water?—From the hot-water tank at Group B mills.

849. There were no kettles there, I presume?—No.

850. How do you bring your tea?—In the ordinary quart can.

851. Is that a can that has been on the fire?—No; we always keep our cans clean.

852. What do you do with the cotton waste for the machines?—That lies on the machines, three pieces at each end.

853. When they are dirty, what do you do with them?—We do not have them all dirty at once, but they are taken away and we get a fresh supply at the end of every week.

854. Was there no box for them outside the house?—Yes.

855. When did you put them into the box?—Every Saturday.

856. *Sir F. Abel.* Where did you keep the dirty pieces?—On the machines. There was always a dirty piece, a half-dry piece, and a dry piece, at each end.

857. With regard to the machines, how often was the washing out done?—Every four racks.

858. Was that a regular rule?—Yes.

859. Were there any instances where you had to do that more frequently?—If we found the pins working badly when new, we should wash them more frequently.

860. Were you always careful to see that the water ran through?—Yes.

861. *Colonel Lloyd.* Have you ever seen a file used in this house, either by a fitter, or by anybody else?—No, I have never seen a file used. If a file were wanted, they would take the thing down to the shop.

862. They would not use a file in the house for the smallest thing?—No.

863. You have never seen one used?—No.

864. Who is responsible for the cleanliness of the floors, and for seeing that the platforms are kept wet?—The boatmen look after the platforms.

865. Does the same boatman attend to everything outdoors for one house?—Yes.

866. Who would be responsible for the cleanliness of this corridor?—The boatmen before they started to roll their powder in should have cleaned it.

867. Can you say whether they did that on the night in question?—I cannot say, because I did not go out.

868. But it should have been done?—Yes.

869. *The Chairman.* Was it raining that night?—No, not until after the explosion.

870. *Colonel Lloyd.* Is that corridor match-boarded as well as weather-boarded?—No, because there are doors here to enable them to see the wheels if they want to.

871. Would it be possible for grit to get into the corridor in any way by means of the wind?—Not unless it was blown from the top of the house.

872. But from the path?—There is a weatherboard on the side *here* about a foot high, and the same *here; this* is fastened in except when the boatmen are doing their work.

873. But in a high wind there would be nothing to prevent the dust from blowing in through the openings in the weatherboards?—It could get in in that way.

874. And grit could get in in that way?—Yes.

875. You are quite sure that passage was not match-boarded?—No, it was weather-boarded.

876. Was the floor leather-lined or was it an open floor?—It was boarded.

877. Were the boards set close together?—Yes, they fitted close like an ordinary wooden floor.

878. Was it fastened with copper nails?—Yes.

879. Do you know if that was a close wooden floor

whether it was not covered with hide, because men were in the habit of rolling barrels over it and it was an inside floor?—I cannot say.

880. Would it be the custom of the factory to leave a boarded floor like that?—Yes, all the houses are left like that.

881. Is it not the custom to cover over closed floors?—Yes, in all the houses, but in places like this they leave the bare boards.

882. Do you know of any regulation forbidding the bringing of tobacco pipes into the factory?—There is a regulation hanging up just as you enter the factory saying that smoking is strictly forbidden.

883. Is there any regulation against a man having a pipe in his possession; when a policeman asks you whether you have any matches, does that include pipes?—Yes.

884. Suppose a man had no matches but a pipe in his possession, would he be dismissed at once if he were found out?—Yes.

885. But there is nothing said about pipes in that regulation?—No.

886. A man may have tobacco?—Yes, for chewing.

887. *The Chairman.* I understand you got out of the door just immedately behind where you stood?—Yes.

888. Carr was opposite to you, was he not?—Yes.

889. Could he have got out as quickly as you did?—Yes, I think so, if it had flashed into his mind what had taken place at the other end. There were two reports at the other end.

890. *Colonel Lloyd.* What was the interval between them?—I cannot say.

891. *Sir F. Abel.* You had no doubt at once what had happened?—I saw the flash, because as I stood at my machine I could see into the passage.

892. Did you say anything to the other men as you went out?—I cannot say.

893. *Colonel Majendie.* Did you see the flash from the first explosion?—Yes, it shot into the passage *here.* [The witness explained the position of his machine, and his own position with regard to the passage, *see* Appendix I.]

894. Do you think you can tell us at all in what portion of the other house the explosion occurred; that is to say, in which corner, or side, or part of it?—I can only repeat what Clayden said when they took him out of the river. He said it was his machine that went.

895. Did he say that to you?—No.

896. If an explosion were to occur in this room you would probably be able to say whether it occurred in this corner, or that corner, but I understand that you cannot say in what part of that house it occurred?—That is so.

897. But you saw the flash immediately after the first explosion?—Yes, through this door *here* (*see* door marked H on plan, Appendix I.)

898. *The Chairman.* Do you think night-work is more dangerous than day-work?—I do not see that it is if you get a proper light.

899. *Sir F. Abel.* Are you satisfied with the light you get?—Yes, we get a very good light at night.

900. *Colonel Majendie.* Have any complaints been made by the men about their machines?—No, nothing more than the pins working badly when they are first put in.

901. Was there any uneasiness in your mind about the machines?—No.

902. Did you think them safe?—We have talked a little in the night, and what would be the consequences if anything happened, and we have talked about how things stood.

903. But you have never shaped your ideas into complaints?—No.

904. Did you ever think the work was especially dangerous; did you consider it as dangerous as the work in a granulating house or in a breaking-down house?—I think a breaking-down house is more dangerous because you might get something in the powder.

905. Have you known of anything being found in the powder in your house?—Only bits of wood that would chip off a barrel.

906. But no pieces of iron or anything of that sort?—No.

(*The Witness withdrew.*)

TUESDAY, 30TH JANUARY, 1894.

Present.

Lord SANDHURST, *Chairman.*

Members.

Colonel V. D. MAJENDIE, C.B., Her Majesty's Chief Inspector of Explosives.
Colonel F. T. LLOYD, C.B., R.A.

Mr. R. H. BRADE, *Secretary.*

Mr. HENRY CRAGGS, *examined.*

907. *The Chairman.* You are the Chief Inspector of the Metropolitan Police at Waltham Abbey, I believe?—Yes, and I have charge also of the police at the Royal Gunpowder Factory, and also at the Royal Small-Arms Factory, Enfield Lock.

908. Have you charge of the arrangements for searching the men at the gate?—Yes; I attend at the gate occasionally, and direct them to be searched.

909. *Colonel Majendie.* How long have you held your present appointment?—Since May, 1892.

910. What are the gates leading into the factory?—The Main gate, the Refinery gate, and the Quinton Hill gate.

911. Is the practice, with regard to the searching, the same at each gate?—Yes.

912. Is there any way by which men can get into

the works other than by coming in at one of these gates?—No, the place is surrounded by water, except portions of Quinton Hill.

913. At what hours do they come in?—Various times, from 4 in the morning up to 8, and from 5 up to 9 at night.

914. And, may we take it, at whatever hour they come in, the practice with regard to searching is always the same?—Yes.

915. What is the practice?—The men are searched indiscriminately, but not every man. There is a serjeant at the main gate, and a constable at each of the other gates.

916. *The Chairman.* And are some members of your force continuously on duty?—Yes, changing every eight hours.

917. *Colonel Majendie.* Have they written orders?—They have printed instructions.

918. Can you give us a copy of them?—They are printed in the General Instruction Book of the police.

919. Can you say what they are?—The police have to patrol the factory to see that there are no trespassers, to see that proper precautions are taken against fire, to lock the gates, to ring the bell for the men to come in and go out, to see that there are no fires on the barges that come in, and if a constable has reason to suspect that any man has matches in his possession he is to search him.

920. "If he has reason to suspect," how would that arise?—Such a case has never arisen in the factory, but those are the instructions.

921. With regard to the constable at the gate, what are his instructions as to searching men?—It is left to the discretion of the police as to what men they should search.

922. But are there always some men searched at every entry?—Yes,

923. And at each gate?—Yes.

924. What proportion of the men are searched?—Here are two returns dealing with the number of men searched, and the articles found in the possession of some of them. (*See* Appendix No. IV.)

925. *The Chairman.* How many men are there employed altogether in these works?—About 800, I think.

926. *Colonel Majendie.* What does the searching consist of?—A man who is about to be searched would be asked whether he had any matches or pipes, and then the constable would feel his pockets, and also round the bottom of his waistcoat, to see that nothing had dropped out of the pockets in between the lining.

927. Supposing matches are found on a man?—He would not be allowed to enter the works. In such a case we generally send for the foreman, and then the man is directed to call again at 9 o'clock to see the Superintendent, to whom I should make a report.

928. Have you ever found a man with matches in his possession coming out of the factory?—No, only going in.

929. Do men frequently admit they have matches before they are searched?—No, in almost every instance in which matches have been found upon a man he was in ignorance of the fact; he has probably been out the night before, and forgotten all about the matches being in his pocket. All those men appeared very much surprised when the matches were found on them.

930. Could you say, roughly, what proportion of the men are searched every day?—About one-tenth, I think.

931. Are there any occasions on which you find it necessary to institute a stricter search than the one you have referred to?—No.

932. Has the searching been conducted in exactly the same way since the accident of December last as it was previous to that time?—Yes, but there have been a few more searched during the last few weeks. After the first match found after the accident the Superintendent requested us to search as many as we could.

933. Since the 1st January, 1894, five men appear to have been found with matches, but in the whole of the previous year only two men were found with matches?—Yes, but those five all joined since the explosion, and we make it a practice to search new men more particularly than the older ones. One of those five was a boy about 15, who had a match and a cigarette in his pocket. It is almost second nature with an old man not to put a match in his pocket.

934. Have the men, before they come to the factory, received any instructions about not bringing matches with them?—Yes; when men apply at the main gate to see some of the officers in order to get taken on for work, the police tell them that they must be very careful not to take any matches in.

935. Do the police tell them that individually?—Yes.

936. Supposing a man has a pipe in his pocket, do you take that away?—Yes.

937. Do you consider that interrogations about matches include pipes?—"Have you any matches or pipes?" that is the question.

938. Do you ask that question of every person entering the works, whoever he may be?—Yes.

939. *The Chairman.* A man would not be dismissed for having a pipe, would he?—No, but he would be suspended for some days.

940. You say that one of the duties of the police is to look after the barges. What barges are those?—The coal barges.

941. Where do they come in?—Some at Quinton Hill, and some at the Refinery gate.

942. Are the men on those barges in the employ of the War Office?—No; they are contractors' men.

943. What sort of regulations are they under?—Precisely the same as other people.

944. Are they searched?—No, but they are asked.

945. Are they allowed to leave their barges at all when in the works?—Yes.

946. Do they?—Yes.

947. Then they are not really under the same control as the regular gunpowder hands?—No, not exactly.

948. But, taking the men employed on the barges, what is there to induce them to give up their matches if there are no consequences?—There is the notice outside.

949. It is an instruction, but it does not go beyond that?—That is so.

950. When they leave their barges they may wander about the works?—No. Perhaps they bring a barge in on a Saturday night and moor it alongside the wharf, and then go away till Monday.

951. May they wander into any of the powder buildings?—No; they are not allowed to wander about the factory at all.

952. Then, as we understand it, this practice of searching is applied to non-powder hands as well as to others?—Yes, to all men in the works department.

953. How high up in the scale does that go? Are foremen subjected to anything of that sort?—Yes. The working foreman, the assistant master worker, is exempt. It does not follow that because a man is searched to-day that he will not be searched to-morrow; one of those men, Poulton, was searched the night previous to the night on which matches were found upon him, but in the first instance he had no matches. The police do not actually put their hands into the men's pockets.

954. Do you make them turn out their pockets?—No, a man is liable to be searched by his foreman after entering the factory.

955. *Colonel Majendie.* As we understand it, what you do is to prevent matches coming on to the factory area rather than preventing them going into powder buildings?—Yes.

956. *Colonel Lloyd.* While you have been at Waltham have you ever known of any case of smoking in the works?—No.

957. Have you known any cases of matches being picked up in the works?—I believe there have been two or three such cases, but I do not know that of my own knowledge.

958. *The Chairman.* Were they found near the barges?—Not very far from the barges, and some few weeks back one was found at Quinton Hill, near the gun-

cotton department, that is about 20 yards from where the barges come in.

959. *Colonel Lloyd.* Would there be any penalty on the contractors' men smoking in the works?—No.

960. Could such a man be had up in the police court?—The case would be reported to the Colonel Superintendent.

961. But you cannot say that there is any punishment attaching to it?—No, I think the Colonel would write to the contractor and say that that man was not to come there again; but as a matter of fact those men are very careful, and they are so accustomed to come there that they hand over their pipes and matches before going in.

(*The Witness withdrew.*)

Mr. Alfred Beales, *examined.*

962. *The Chairman.* You are the master millman at Waltham Abbey, I believe?—Yes, I have to superintend all the incorporating mills under the master worker. I have to see that the work is properly carried out, that the charges run the proper time, to see that a proper moisture is maintained, and to keep an account of what each mill turns out. That is my work in the daytime. At night I have also to visit all the houses, to see that the work is being carried on properly. I visited No. 2 cam house, and after going to the north end to see that all was right, I passed on to the south end, and there I saw Bailey, the foreman. I asked him if everything was all right, and he said yes.

963. *Colonel Majendie.* As I understand it, you have not the control of the houses, but you have a duty of supervising them, by having to visit them at night?—Yes, to see that everything is all correct.

964. What do you mean by "all correct"?—I go to them and ask if everything is all right; if anything is wrong the foreman reports it to me, and I make out a detailed report for the master worker next morning.

965. If there were any deficiency in the supply of powder, or anything wrong with the machinery, would that be brought to your notice?—Yes.

966. Are you there every night?—I take weeks about, and I have done so for the last 30 years.

967. Did you know all the men employed in that cam house?—I have seen them there.

968. Were they a steady lot of men?—Yes; I have heard no complaints about them. The foreman I knew from boyhood; he was very steady, and he took a very great interest in his work.

969. When you went to this building, what was going on?—I went to the north end first, and all the machines were at work, and the men too. As I did not see Bailey there I went to the south end along the outside path.

970. What was going on in the south end?—The men were all at their work, and Bailey was standing with his back to the door. I asked him if all was correct, and he replied that everything was correct.

971. Were the men working in there in their proper clothing?—Yes, they all had their lasting suits on.

972. You did not look at their underclothing?—No, I did not.

973. Does that form part of your duty?—No; that would be the foreman's duty.

974. Did he carry out that duty always?—That I cannot say.

975. Have you ever seen him do it?—No, because his men changed in the shifting room, and he would do it there.

976. Were the men steady that night; was there any skylarking going on?—I have never seen any skylarking going on, and I believe Bailey would be the last man to allow anything of that kind.

977. Have you ever known any cases of smoking?—No, not in the factory.

978. Do you think it would be at all likely for any of the men to do that?—No.

979. From your experience of the men, would you say that if any man attempted to do that sort of thing the other men would be likely to interfere with him, or do you think they would wink at it?—I do not think they would allow such a thing to be carried on.

980. Nor in the shifting room or dining room?—No, not in any part of the works whatever.

981. Do many of the men chew tobacco?—I think it is the practice with a great many of them.

982. You have been round this house very often at night, but have you ever been there when the men have been taking their meals?—I have been there when the machines were stopped for meals.

983. Where have you seen them taking their meals?—In the dining room, which is close by.

984. Have you ever seen them taking their meals in the shoe room?—No.

985. Do you know, as a matter of fact, whether they are in the habit of having their meals in the shoe room?—I believe in some houses they do that.

986. But take this particular house?—There is no place for them to sit down such as there is in the granulating house and the press house.

987. But taking such a place as the press house where they have a shoe room, would they bring their plates and kettles, and such like things there?—They would bring their tea made from the dining room.

988. How would they heat it?—They would make it hot in the dining room, and bring it up with them, and, perhaps, stand it on the steam pipe to keep warm.

989. Would they bring up the tea in the same vessel they had heated it in the dining room?—No.

990. So that there would be no chance in that way of fire being introduced in the house?—No.

991. When you have been going round, have any of the men made any complaints to you about anything being wrong with the machinery?—No, nothing further than the breaking down of a plunger. When I have asked Bailey, he has sometimes said that No. 1, 2, or 3 has stopped on account of a plunger breaking, and he has gone on with the next machine, if there has been a spare machine standing. In all these instances I have reported the case next morning.

992. Have any complaints been made to you about the pins or other parts of the machinery getting heated?—No.

993. Did Bailey keep you from conversing with the men?—No, never. I have asked Bailey before the men, and they could have said at once whether Bailey was correct or not.

994. Would Bailey have any interest in saying a thing was right when the thing was wrong?—No.

995. The condition of the machinery did not rest upon Bailey, I presume?—No.

996. Supposing the machinery broke down, who was responsible for that?—The chief engineer.

997. Have you ever seen any person repairing the machinery in that house?—No, nothing further than seeing Bailey altering the plungers.

998. What did he use to alter them with?—A spanner.

999. A steel spanner?—I cannot say whether it was steel or not. In those circumstances the machine would be stopped and washed out.

1000. Would all the powder be moved from the house, or from the other machines?—I think not.

1001. Were you on the scene of the explosion soon after it occurred?—Yes, I was near the mill head at the time, and in going round to where I thought the explosion was, I met a man who said that the cam house had exploded.

1002. Was he one of the injured men?—No. I said to him, "Go and call Jackson, the fireman, and then go and call Captain Nathan."

1003. Did you see any of the injured men at the house, or near the house?—When I got down there I went into the wash-up house, and most of them were there.

1004. Did you see Watts?—No, I saw the water-warder, and I understood from him that he had them all there except Bailey, who was in the river; and so I went to search for him.

1005. Did you see Watts at all?—No.

1006. When you were in the house, before the explosion, did you notice whether Bailey or any of the others were using the small hand electric lamps?—I did not see any of them.

1007. You have seen those lamps in use, I suppose?—Yes, I have one of them myself.

1008. When you saw the men in the house, after the explosion, were they in their regulation clothing, so far as they had any clothing at all?—Yes.

1009. I suppose you have often seen the powder brought into the house from the boat by the boatmen?—Yes, I have seen it rolled in.

1010. How?—On the chine.

1011. Have you ever seen them do anything else than roll it on the chine?—No, I have never seen it dragged along.

1012. Do you know the two boatmen, Hare and Watts?—I have seen them.

1013. Were they new hands, or were they men who had been there for some time?—I think they had been there only a short time, probably about 12 months.

1014. Had they full knowledge of the duties of boatmen?—Yes.

1015. Have you ever seen Watts take a barrel into the house?—Yes, I have been in the house when they have been rolling the barrels in.

1016. This particular man, Watts?—I cannot say for certain.

1017. But one or other of the two men?—Yes.

1018. And they were men who rolled the barrels always on their chines?—Yes.

1019. How long does it take you to get round the houses at night?—About one and a-half or two hours.

1020. Do you go near to Quinton Hill?—No, I have only to do with the powder branch.

1021. Do you visit all the danger buildings?—Yes, I make it a point to always see the workmen there.

1022. Do you go into many of the other houses?—I see the press house, the granulating house, and the blending house, besides the mills.

1023. And the glazing house?—Not very often.

1024. In looking over these houses have you seen anything which you consider will in any way throw any light upon the cause of the accident?—No, I have thought over it, but I cannot throw any light upon it in any way.

1025. Have you seen any explosion before?—Yes, I have seen several, but we are not so unfortunate in that respect as we were. I think we have now a better class of runners, and we run heavier charges, which are, I think, safer than the old 50-lb. charge; we now run 80-lb. charges, and with a charge of that description the bed of the mill is very much better covered.

1026. *The Chairman.* What are the beds of those mills made of?—Stone and chilled iron.

1027. Are they started from the outside, and self-acting?—Yes, but the millman has to look after them, because we have to study the weather, which has a very great effect upon incorporating gunpowder. Sometimes we take as much as 18 to 20 pints of liquor away, and at another time, when the atmosphere is very dense, we should not take more than one-third of that quantity. So you see we have to study the thing pretty closely, so as to bring the powder off at a certain moisture.

1028. *Colonel Majendie.* Do your men go into the mills while they are working?—Yes.

1029. Then at that time they are exposed to a great risk?—Yes, but they are protected as much as possible.

1030. When did you last have a mill accident?—11th March, 1892; it exploded on a 60-lb. charge, after running about 7¾ hours. I had never known a charge to explode after running so long before.

1031. *The Chairman.* When you are on night duty, are your visits to the various mills made at all sorts of hours?—Yes, the men never know when I am coming.

1032. Do you make any formal reports to say that you have been round and that all is right?—No, I do not make any report except in the case of something going wrong.

1033. *Colonel Lloyd.* Is it your custom to go round early in the morning, say between 2 and 5?—Yes, I occasionally go round the last thing before I shift my clothes, to see that everything is correct.

1034. It is a common thing for an incorporating mill to blow up, is it not?—Yes, but we have not had so many accidents lately.

1035. Has it ever, to your knowledge, been suggested that some other material than iron should be substituted for the beds of the incorporating mills, such, for instance, as phosphor-bronze?—Some years ago the engineer we had spoke to me about having rings put on the runners, but I think it was said they would not be hard enough, they would wear out too soon. The runners are faced up every now and again, so as to get smooth surfaces on them.

1036. *Colonel Majendie.* Are any of the new runners stone runners?—No, they have not been put in in my time.

1037. *Colonel Lloyd.* Have you known of any experiments being made to ascertain whether any other material could be used that would not be liable to strike sparks?—Not in our factory.

1038. Have you been a foreman?—Yes.

1039. When you were a foreman was it ever your habit to search the men?—Yes.

1040. When you searched them, did you anticipate finding anything, or did you merely do it as a matter of routine?—I hardly did that.

1041. Do you believe the searching is still done?—Yes.

1042. Are men allowed to bring pocket-knives into the factory?—To the wash-up house; but they have no other means of taking them except in their baskets.

1043. Do they require them for eating their dinners?—Yes, I think they would.

1044. Have you known of men eating their dinners in any other place than the dining room?—I have seen them in the shoe room.

1045. Did you ever see them use their knives there?—I cannot say that I have.

1046. Would it be against the rules to do so?—There is no rule to that effect. The rules state that men are cautioned against carrying knives when employed about the mills or powder houses.

1047. If a man put his knife into the front of his shirt, having no pockets, after his dinner, would any other workman see him do that?—The foreman would report him, no doubt.

1048. Have you ever known any such case?—No.

1049. Is any examination ever made of the shoes that the men wear, to ascertain whether they are serviceable and clean?—The master worker examines them, and passes them when they come in.

1050. Is there any periodica examination of them?

—I think not. Repaired shoes are not allowed in the powder vessels, but they are allowed for the mill men.

1051. Are the shoes ever cleaned, or brushed in any way?—We have mats laid down at every door.

1052. Is it anybody's duty to see that they are clean and free from grit?—Only the men themselves and the foremen in the house.

1053. Would there be any examination of the shoes; has it ever been suggested to you that the shoes might have grit on them?—No, I do not see how they could get grit on them, because they never go out of the house.

1054. The surfaces of the platforms are liable to have grit on them?—Yes, but they are constantly being washed down.

1055. Occasionally grit may get on?—Yes.

1056. And sharp grit may get into the soles of the shoes?—Yes.

1057. Have you ever known men work without their shoes; has a man ever said that his feet are tender, and that he would work in his bare feet?—No.

1058. Would that be forbidden?—Yes, I think so; I think the foreman would not allow men to walk about the place in their bare feet. I would not allow such a thing. I should consider it against the regulations.

1059. *The Chairman.* When you go into the houses, do you yourself put on these slippers?—Yes.

1060. Would it not be a wise precaution to have the soles of these shoes inspected, to see whether they are free from grit?—Yes, I think if a foreman examined those shoes every morning it would be a good thing.

1061. Do you also wear lasting-cloth clothes when you go round the houses?—Yes.

(*The Witness withdrew.*)

Mr. Walter J. Chittenden, *examined.*

1062. *The Chairman.* You are a foreman in the Royal Gunpowder Factory, I believe?—Yes.

1063. How long have you held that appointment?—About seven years.

1064. What are your duties?—I am employed in the master worker's office. I see the men in, I keep the time and work books, I check the work done, and I occasionally visit the men at the powder houses.

1065. Have you a gang of men under you?—No, I am doing only general work.

1066. In what part of the factory are your particular duties; were you engaged in this cam house?—No, but I visited there occasionally to see if they were at their duties, and I also asked the foreman if everything was working all right.

1067. To whom are you responsible?—To the chief foreman, and through him to Mr. Findlay.

1068. *Colonel Majendie.* Does the chief foreman, Turnham, still go round?—Occasionally.

1069. Do you go round every day?—No, not every day.

1070. When do you go round?—When there is no one else to go. Mr. Findlay's son goes round when Turnham cannot go, and when Findlay does not go, then I go.

1071. Do you go round at night as well as in the day?—No, I have not been on night duty.

1072. What is the object of your going round?—To see that everything is working all right.

1073. Does that apply to the machinery?—To everything.

1074. Supposing there was too much powder in any house?—I should report that.

1075. Would you report men for not being properly dressed?—Yes.

1076. Do you have to do directly with the machinery?—The foreman would report such things to me.

1077. You do not examine the machinery yourself, do you?—Only just cursorily; I examine the prisms, and gauge them.

1078. Supposing a machine was broken, or was working badly, would it be the duty of the foreman to call your attention to that?—Yes.

1079. Has Bailey ever called your attention to anything wrong with the machines?—No, I had not gone down there since the Friday before the explosion, and then they were repairing the machines.

1080. What were they doing then?—The fitter was in the house putting a pin into No. 3 machine, and Nos. 4 and 5 were waiting for him to deal with; they had washed them out, and cleared the powder out of the house.

1081. Had the pins worn, or were they broken?—A set of pins will last about three weeks, and then they begin to wear.

1082. Are they phosphor-bronze pins?—Yes, and when they are worn they make untrue prisms.

1083. Is it the practice to remove powder before any work is done in the way of repairing the machines?—Yes.

1084. Would you consider removing a pin as a repairing operation?—Yes, when they have the fitter in.

1085. Is there any work that Bailey might do without calling in the fitter?—He would put liners under the plungers when they are worn.

1086. In order to do that, what would he have to do, would he have to unscrew some portions of the machines?—Yes.

1087. Would he do that without calling in the fitter?—Yes; that is what we call adjusting the plungers.

1088. Would he clear the house of powder for that purpose?—I think not; he would wash the machine and the plunger, and he would clear the machine out.

1089. Were the machines liable at any time to have powder encrusted upon them at any part?—Not if they washed them out.

1090. Supposing they did not wash them out, where would there be any incrustation of powder?—In the pin-hole.

1091. Have you ever seen that happen?—No.

1092. Then it is merely your belief that it would happen?—I know it does happen; that is why they have to clear out the holes.

1093. What else would a foreman do to the machines?—He would alter the cross-heads, that would be for the purpose of increasing or decreasing the density.

1094. Would he require to use a spanner for that purpose?—Yes, a small spanner.

1095. Would he remove the powder?—No, I think not.

1096. Were the plungers and the pins often broken?—Yes, that was of frequent occurrence.

1097. Ought a fitter to do those repairs?—Yes.

1098. Have you known the foreman to do them without the fitter?—I believe he has occasionally to put in a pin, but not a plunger.

1099. Would he have to replace a broken pin?—Yes.

1100. Would he clear the house of powder for that purpose?—I cannot say, but I think not.

1101. Have you ever seen him do it?—No.

1102. I do not see any cam-house rule which says that the house is to be cleared of powder before any of the repairs are done?—I do not know of any printed rules about that.

1103. Do you not think it is desirable that there should be a regulation to that effect?—Perhaps it would be well, after the experience we have had.

1104. Are you aware that there have been accidents elsewhere due to repairing the machines while there was powder still in the house?—I believe that at Hay & Merrick's they had such a thing happen.

1105. Did you hear of one that happened at Kame's factory?—Yes.

1106. At any rate, we may take it that you think it is desirable that such a rule should be observed?—Yes; when a machine is under repair, the powder should be removed.

1107. Have you ever seen any of the men repairing the machines?—No.

1108. Whereabouts in the house were the spanners generally kept?—In a cupboard in the shoe-room.

1109. Do you know where the spanners were found after the accident?—No.

1110. Have they been found?—I think the screw-wrench has been found, but I do not where it was picked up.

1111. How soon after the accident were you on the spot?—In about half an hour.

1112. Did you see Watts?—Yes, I was there when he was found; in fact, I was searching for him.

1113. Had his body been moved at all when you saw it?—No. In the old mill there was a brick trench underneath the floor, and he was in there under a charred beam, with his head turned *that* way. [The witness explained the position of the trench, and pointed out that Watts was lying close by the machine, with his head towards the north, and his legs under the *debris*.] It seemed as though Watts had dropped into the trench.

1114. Was Watts dead when you found him?—Yes.

1115. Was he injured by explosion at all, or only by burning?—As far as I could see, his head was burned, you could see his brains; his arm and part of his trunk were burned away.

1116. Which arm?—The left, I think.

1117. Were the arm and the missing portion of the head on the same part of the body?—Both on that side.

1118. And you say you think it was the left side?—Yes; I believe he was lying on his face when the fireman picked him out.

1119. Were his limbs otherwise uninjured?—No, he was burnt all over.

1120. Were his limbs all there?—I could not say, I did not assist to get him out.

1121. Did you then, or at any other time, see any portion of a barrel which might have contained powder?—There was some out *here* [pointing to a spot on the plan between the south end of the building and the head-stream. *See* Appendix I.]

1122. Did you find anything *here* [pointing to the spot where Watts's body was found. *See* Appendix I.]?—No, everything was burned there.

1123. With the exception of Watts, all the other men were out of the house when you got there, were they not?—Yes, I saw them in the shifting room.

1124. About how far was Watts from these two machines, would you say half way between the walls and the machines?—I think the trench was about 2 or 3 feet away from the machines.

1125. Can you say what the total distance is from the wall to the machine?—I cannot say for certain, but I think it is about 8 feet, and the trench would be rather more than half-way towards the machines.

1126. Did you see the trench before the explosion?—No.

1127. Did you know of its existence before that?—No.

1128. Did you ever see Watts, or anybody else, bringing powder into the house?—I cannot remember any particular man.

1129. Have you ever seen a man lift it up *here* [pointing to the spot marked B¹ on the plan. *See* Appendix I.]?—No.

1130. Had you anything to do with regard to the men's clothing?—No, the foreman would be responsible for that; Bailey would examine his men.

1131. He should examine them?—Yes, when they came to the house.

1132. And not in the shifting room?—No, we have a special man there.

1133. In going your rounds, did you ever say to any of the men: "Let me look at your underclothing, and see if you have any pockets"?—No.

1134. Have you ever seen anybody do that except Bailey?—No.

1135. Have you ever seen the men searched?—Yes; I have been searched by the foremen myself.

1136. In what house?—The mixing house.

1137. Who was the foreman?—King.

1138. How often did he search you, every day?—Yes, I think so.

1139. Does any man go out of the factory between the time of coming in in the morning and going out in the evening?—No, not the workmen.

1140. Would there be any opportunity for a man to change his clothes in the course of the day?—Of course there is an opportunity, but the foreman would not allow the man to go away. The policeman would not let a man out without a pass from his foreman.

1141. Would a man be able to go back to the shifting room and change his clothes?—Not without the foreman knowing, because the work would be delayed.

1142. But would he be able to do so during the meal time?—Yes, he could go then.

1143. And would a man have access to his clothes at that time?—Yes.

1144. If he felt cold, and had not got a waistcoat on, he could put one on there?—Yes, he could do so.

1145. And the foreman would not know of that, would he?—Not unless he missed the man.

1146. But a man must, in the course of the day from time to time, leave his work for a certain purpose?—Yes.

1147. Might it not be supposed that he was away for that purpose?—Yes.

1148. At any rate the door of the shifting room would be open to him?—Yes.

1149. Have you ever known of any smoking on the works at all?—No.

1150. Would the men stand one of their number smoking?—No.

1151. *The Chairman.* Are the men suspicious of one another in bringing things in?—No, of course they all go together to the shifting room, and they watch one another.

1152. *Colonel Majendie.* Have you ever known of any man attempting to smoke?—No.

1153. Not even in the shifting room, or in the meal room?—No.

1154. Has the question of allowing the men to smoke in the shifting room and some other parts of the works ever been considered or suggested at all?—No, not by the men, or by anyone else.

1155. Are you aware that the practice of private factories differs in that respect from yours?—I was not aware of that.

1156. Did you know all the men in that house, more or less?—Yes.

1157. Were they generally a steady and experienced lot of men?—Yes.

1158. There were none of them young hands, were there?—Rudd was the youngest; he had been there only about a month.

1159. Had Watts been employed there for some time?—Yes, he was an experienced boatman.

1160. Had he ever been punished, or found fault with?—No, he was discharged on reduction in April, but he was taken on again.

1161. Did you know Bailey well?—Yes, he was an apprentice with me.

1162. Was he steady?—Yes.

1163. What was his age?—About 32 when he died.

1164. How long had he been foreman?—For about five or six years; he was in charge of the cam machines

when they were first started in 1887, and he had had charge of that house since.

1165. Did you personally find Watts's body, or did somebody else find him and call your attention to him?—Jackson, the fireman, found him. I was walking towards the place when they found him.

1166. Do you think you can say positively that he had not been moved at all when you saw him?—Yes, I think so.

1167. Were they able to move him without taking the beam away?—Yes, I think the fireman said he got a piece of wood and moved him on that.

(The Witness withdrew.)

Mr. Edward Jackson, *examined.*

1168. *The Chairman.* You are the chief fireman at Waltham Abbey, I believe?—Yes.

1169. For how long have you held that appointment?—Seven years come July.

1170. What are your duties?—To see to all the fire appliances, and to see that the engines are in proper working order in case of fire.

1171. What staff have you?—Only two men in uniform, but I drill about 50 or 60 of the other men every month.

1172. *Colonel Majendie.* What are your duties in the daytime?—To see to the fire appliances, and to be ready to drill the men at all times.

1173. Then I understand you have nothing to do with the buildings, or the making of powder, or the boats, or the barges?—No.

1174. How soon after the accident were you on the scene?—In about ten minutes; I was at home when it happened.

1175. How far is your house from the works?—I live just by the Refinery gates, that is about five minutes' walk.

1176. What first directed your attention to the accident?—The ringing of my bell. When I got there the men had already got the engine out, but it was not actually working.

1177. Was the house fully alight at that time?—Yes, and burning with great violence.

1178. Did you hear anything in the nature of an explosion?—No, not till about 20 minutes after the fire had been burning, and then I heard a slight explosion.

1179. How soon afterwards were you able to make search for the bodies?—As soon as I possibly could; of course we do not wait for every spark to be out. The first intimation I had about Watts was from Bailey, when I pulled him out of the water in the tail stream. When I pulled him out I asked him if he were burned, and he said no, but I got him on to my back and carried him in the usual way to the dining room; he was quite numbed with the water. As we were taking him to the hospital I asked him if he had any idea of where Watts was last seen.

1180. Why did you ask him for Watts?—Because he was the only man missing at the time. Bailey told me that he last saw Watts rolling a barrel of powder close to the machines. I then went back from the hospital and made a search, and I found Watts *here.* [The witness pointed out the exact position on the plan.]

1181. Which way was his head lying?—Towards the north end.

1182. Did you notice what his injuries were?—Yes, part of his head was blown off and his brains were lying underneath.

1183. Were his limbs injured?—Yes, both arms were off, and both his feet, his side was burned away and his entrails looked as though they were roasted.

1184. Were the arms blown off?—I think they were burned off, and I should say the same with regard to his feet. He was lying in the trench and the beam was resting on the brick wall. I put my hands underneath the body and it dropped a little as I pulled the *débris* away.

1185. Was he on his face?—Yes.

1186. As far as you can recollect which side of his head was injured?—It was the left side. [The witness then explained how, by means of a piece of wood, he was able to get the body out of the trench.]

1187. Did the man's head appear to you injured by the explosion?—Yes, I think so, because part of it was blown right off. I do not think it was a burn, because, if it had been, the brains would not have been mixed with the *débris.*

1188. Was there any other evidence of an explosion about the body?—Only in the case of the hand, I think, which was afterwards found.

1189. Where was it found?—Somewhere here [pointing to a spot marked L on the plan to the north end, between the house and the water, Appendix I.], but how it got there I cannot say.

1190. It might have been blown there?—Yes, the hand was almost as clean as mine is now.

1191. Were any other portions of the poor fellow found?—No, although I made a minute search.

1192. I understand that none of the other men who died had any portion of their bodies blown about?—No, they were burned.

1193. Had they all their regulation clothing on as far as they had any clothing at all?—I could not say, because I did not have much dealing with them until they were stripped.

1194. Did you find or see the remains of a barrel *here* [pointing to the spot where Watt's body was found, Appendix I.], any staves or anything of that sort?—Nothing at all.

1195. Had it all disappeared?—Everything was burned in the south end.

1196. Was the fire more violent in one place than in another?—No.

1197. How about the boat?—That was pretty well sunk, and the hood was blown off it.

1198. You say you heard nothing of the explosion?—No, I did not; I am a very light sleeper, and very easily awakened, but I did not hear any noise. The west wall is intact, but if there had been a very violent explosion that would not have been there, and the same with regard to the mills on the other side of the stream which have tanks over them. If there had been a very violent explosion it would have capsized those tanks.

1199. *The Chairman.* With regard to your not hearing, is your house in the same direction as the wind was blowing from?—Not exactly on that night.

1200. We understand there was a gale of wind?—It was not so severe at the time of the explosion as it was three hours before.

1201. *Colonel Majendie.* Was it raining at the time of the explosion?—Yes.

1202. Was there lightning?—I did not notice.

1203. Did you know Watts?—Yes.

1204. Was he a steady man?—Yes.

1205. Had you ever seen him doing his work?—No.

1206. Where did you get your water from?—From the river between the cam house and the magazines.

1207. Where was the engine kept?—Just by the dining-room.

1208. How long did it take you to extinguish the

fire?—It took me rather a long time, that is, comparing it with a good many fires I have been to. I had only a 5-inch pumping-engine.

1209. Is this the most powerful engine you have?—No, I have another near the cordite factory, and in various places I have hydrants with 145 lbs. pressure to the inch.

1210. What other manual engines have you besides this one in the factory?—I have 12 altogether; this one is for the Lower Island alone.

1211. Do you think you want a more powerful engine?—Yes.

1212. Have you made any application with regard to that?—Yes, before the accident. I have also applied that hydrants might be laid down to the Lower Island, but the authorities would not allow them, after the Superintendent using his best endeavours to get them.

1213. Would you rather have hydrants than an engine?—Yes, because two men can get a hydrant to work, whereas it takes 16 to work an engine.

1214. Could you get a good pressure for the hydrants here?—Yes, 145 lbs. to the inch.

1215. Is that the only part of the factory where you have asked for hydrants?—Yes.

1216. Have you had occasion to use your engines for any other accident since you have been at Waltham Abbey?—Yes, on the 22nd August, 1890, there was an explosion at No. 1 breaking-down house, and two men were blown to pieces.

1217. Have you used them for a mill accident?—Yes, at group E, which fired one Monday morning. We used the hydrants on the guncotton store at Quinton Hill, and it did not take us so long to deal with that as it did with these small buildings.

1218. *The Chairman.* Did you see any of the felt flying about from this blazing roof?—Yes, there was very little wind, but I told the men to go about the platforms with buckets of water.

1219. Is there any danger to be expected from these felt roofs in cases of fire when the wind is high?—Yes. Felt is very light, in a case of fire it is as light as cork.

1220. Would you like to see all this roof made of zinc?—Yes, I think that would be an improvement; a felt roof is not a proper thing in a place like this, especially as it perishes after 12 months' wear, and then requires a coat of tar.

1221. Supposing you had had these hydrants, and supposing the firemen had been on the spot, I suppose nothing could have saved the life of this poor man, Watts?—I think not; I think he went as soon as the first explosion happened, and I do not think he was far away from the explosion.

1222. Then you think the explosion took place in his own barrel, as far as you can form an opinion?—Yes, but of course it is only my idea. All these machines were working as perfect as anything could work, until the main beam fell across the waterwheel and that stopped them.

1223. I understand that some of the men were picked up from the water?—Yes.

1224. How did they keep themselves up; is the water deep?—In some places it is 10 feet deep, but in places there is a bank; which has been caused by the constant washing of the water from the wheel, and they could stand on that. Bailey, I think, was washed across from the wheel on to the bank, and when he regained his consciousness he struck out for where he could see the fire and hear the noise of the engine. When I heard Bailey calling for help I called to my man named Brown to come and help me, and when I pulled Bailey out he was as sensible as I am.

1225. Was he very much burned?—Not very much.

1226. *Colonel Majendie.* What was it that killed him?—The water, I think, because mortification set in with him.

1227. Did Bailey say anything about Watts?—No, I spoke to Bailey several times after the accident.

1228. Did he say anything that would throw any light upon the question?—No.

1229. Did he make any suggestion with reference to it?—No, I asked him where he last saw Watts, and he told me.

1230. *Colonel Lloyd.* Did you see Rudd and Rudkin after the accident?—Yes, in the hospital.

1231. Were they burned more on one side than on other?—I could not say, they were burned about the face.

1232. Did they bear any signs of a violent explosion?—No.

1233. Did the fire absolutely burn itself out?—No, it was extinguished by me.

1234. Did you make any search for signs of fire all round the house?—Yes, and to see if I could find any more remains of Watts.

1235. Did you find the hand then?—No, it was found by some of the workmen.

1236. There was no doubt it was his hand?—That is so.

1237. When you were searching, did you find anything about which would give you any reason to believe that they had occasioned the explosion?—No.

1238. Were any tools found?—Yes, a spanner.

1239. Where was that found?—In the shoe house.

1240. Was the door of the shoe house burned down?—Not when I first arrived there, but parts of it got pretty well burned down by the end.

1241. Were any other tools found in the shoe house?—Not that I know of.

1242. Were any other tools or implements found in the building that was burned?—Nothing beyond the ordinary tools.

1243. Were they found where you would expect to find them?—Yes.

1244. Did you find the spanner?—No. They could not possibly use a spanner on those machines when they were working, and as a matter of fact, they were all working after the explosion.

1245. *Colonel Majendie.* Is there any work that could be done with a spanner on any of the standing parts of a machine?—No.

(*The Witness withdrew.*)

Mr. A. W. Brace, *examined.*

1246. *The Chairman.* You have been employed as a boatman at Waltham Abbey, I believe?—Yes, from April until August, and since then I have been employed in the cam house, on No. 2 machine.

1247. How long have you been in the factory altogether?—About 3½ years

1248. *Colonel Majendie.* Did you work with Watts in the boat?—No.

1249. Have you ever seen Watts during his work—No.

1250. When you first became a boatman, who told you to act as such?—I had my orders from the master worker's office.

1251. But when you first became a boatman, did you get any instructions from anybody?—One boatman instructed another. The man I was working with was an older hand than myself.

1252. Was Bailey at the cam house when you first became a boatman there?—Yes, I had one week with him.

1253. During that time, I suppose you frequently delivered powder into both parts of the house?—Yes.

1254. I understand you lifted the powder out *here* [pointing to the end of the platform marked B on the plan, Appendix I.], and rolled the barrel along on its chine?—Yes.

1255. And then *here* [pointing to the spot marked B^1 on the plan, Appendix I.] there was a little step?—Yes, about 9 inches high.

1256. How did you get the barrel up?—I lifted it up, by putting one hand at the top and one hand at the bottom.

1257. Was there any difficulty in doing that?—No, it was the easiest way to do it.

1258. Which side did you trundle the barrel, did you trundle it to your right?—The left hand went first.

1259. When you got it *here* [pointing to the spot marked B^1 on the plan, Appendix I.], you deposited it on the bottom, and then lifted it up?—Yes.

1260. Did you then roll it on, or leave it there?—We rolled it on to the machine.

1261. How near?—Until we got directly behind the machine, where the man feeding the hopper stood.

1262. Were those barrels inconveniently heavy to move?—Not when you were used to them, though they were a little awkward to begin with.

1263. Who told you to roll the barrel on its chine when you first went to work?—It is in the rules.

1264. And you knew that rule about the open powder barrels and charge tubs, and observed it?—Yes.

1265. Have you ever seen a barrel dragged along?—No, it is easier to roll them.

1266. Is there any special difficulty in getting a barrel up this step?—No, none whatever.

1267. Is there any way by which a man could make it easier for himself?—No, the easiest way would be to lift it.

1268. When you were at that house and had rolled the barrel in, how would you stand with regard to the barrel?—I should lift it with the right hand at the bottom and the left hand at the top.

1269. With your left side towards the barrel?—Yes.

1270. Do you know whether other men rolled it on their right side?—I think they all rolled it as I rolled it.

1271. Trundling it with the right hand and guiding it with the left?—That is so.

1272. Have you ever seen a left-handed man work it?—No.

1273. You never saw Watts doing it?—No, he was in the opposite shift to me.

(*The Witness withdrew.*)

Mr. S. Mumford, *examined.*

1274. *The Chairman.* You are a workman in one of the powder houses in Waltham, I believe?—Yes.

1275. How long have you been there?—About two years.

1276. What house are you working in now?—No. 5 moulding house.

1277. *Colonel Majendie.* Where were you working at the time of the explosion?—In the cam house, on the day shift.

1278. When were you last in the house?—I came out at 6 o'clock on the Tuesday night as the accident occurred on the Wednesday morning.

1279. Whom did you work under?—Mr. Ephgrave.

1280. I suppose none of the men who were in the house at the time of the explosion were working with you?—No.

1281. Where did you work?—On No. 4 machine, in the north end.

1282. How long had you been working there?—Between seven and eight weeks.

1283 Had you worked all the time at this particular No. 4 machine?—I once went down to No. 1 machine, which is a spare machine in a separate place.

1284. Who was your mate on this No. 4 machine?—Up to Friday night a man named Argent, and then I had three different mates between the Friday night and the Tuesday night.

1285. With regard to this particular machine, had it been subjected to any repairs during the time you had been in the house?—New pins were put in on the Friday before the explosion.

1286. Who put them in?—I could not say, perhaps the fitter; they were put in in the daytime as we came in at night.

1287. Who usually put in the pins?—Johnson, the fitter.

1288. Have you see him do it?—No.

1289. Have you seen anybody else do it?—No.

1290. Have you seen the foreman do it?—No.

1291. Have you not done it yourself?—No, not put a pin in.

1292. Have you seen the fitter at work on the machines?—Yes.

1293. What work have you seen him doing?—Putting in new plungers and new bands for the cross-heads.

1294. When he did that were the machines cleared of powder?—Yes, they were always cleared out when that was done.

1295. Have you ever seen your foreman do any repairs to the machines?—Nothing except tightening the plungers and altering the top cross-heads if the powder was light or heavy.

1296. What did he use for tightening up the plungers?—A steel thing like a key; it is not like a spanner.

1297. Was there a spanner for each compartment?—There were three laid about in the house, a pair of pin pliers, and a shifting spanner for altering the nuts of the top cross-heads.

1298. But speaking for the men generally, did they use any tools other than the spanner, can you remember?—No, nothing except a little prober which is used for cleaning out the plunger. There was a piece of wood used for tapping the pins known as a tap-stick.

1299. What was the prober made of?—Metal.

1300. Any other tools?—No.

1301. Was there any work which you could do on the machines in regard to tightening them up or anything of that sort while they were running or working?—No.

1302. You always stop the machine?—Yes.

1303. Could it be done without stopping the machine?—Yes.

1304. Can you follow up the thing as it runs on full?—Yes, you can do the outside screw, but not the inside one.

1305. But you have never seen it done?—No.

1306. When the plungers were tightened were the machines cleared of powder?—No, there was very often powder in the bushes.

1307. When they were doing it and when you have done it?—Yes, I have done it when there was powder in the bushes.

1308. Did you consider you were acting in accordance with the regulations in doing that?—There was no regulation against it.

1309. Are you familiar with these regulations for the cam house, Lower Island, they were stuck up in the house, were they not?—Yes.

1310. Have they been read to you or by you?—They have never been read to me but I have read them.

1311. Have you ever read this one, "No persons, except those who are properly instructed and duly authorised, are at any time to meddle or interfere with the machinery," do you know that rule?—Yes.

1312. What does it mean?—That you are put there to work the machine, and if anything goes wrong you have to alter it, if a plunger goes wrong you have to put it right.

1313. I suppose the loosening of the plunger was a defect?—It was a strain upon it, I think.

1314. Would you get defective working in the machine if the plunger was loose?—Yes.

1315. And to rectify that you would tighten the plunger up?—Yes.

1316. Would that be consistent with rule 7 which says, "Any defect in the machinery, or any repairs required, should be at once reported to the master worker and to the foreman of machinery, Lower Island." In the cases where you have done such work have you made a report to the master worker?—We used to speak to the foreman.

1317 When you wanted to tighten up a plunger did you go to Ephgrave and say, "May I tighten up my plunger"?—No, but we almost always told him there was one loose.

1318. Have you had any experience with Nos. 2 and 3 machines?—I have worked with No. 3.

1319. Have you had the same difficulty with that in regard to tightening up the plungers?—Yes, you would tighten them up just the same.

1320. Have you ever had broken pins?—Yes, on No. 3 that happened; I think it was caused by packing up a double interval of prisms, and one flew back and got between the bush and the plunger and broke the pin.

1321. In that case who repaired the machine?—I cannot say, it was more than 12 months ago.

1322. Did you say anything to anybody about that?—No, I was only a fresh hand down there, and I left it to the older hands.

1323. Do you know anything about the No. 2 machine?—I have seen a great deal of trouble with it.

1324. What sort of trouble?—With the pins; we could not get the water down. After every four racks water is supposed to go down through the plunger, and down through the bottom crosshead, but it would not go down.

1325. Why?—Either the pins were too large, or the holes in the plunger were too small.

1326. Was there the same difficulty with the other machines?—When there were new pins put in all the machines worked very badly in that way.

1327. Had there been any alteration in the pins down to the day before the accident?—On that particular day in No. 4 they ran better; they had just begun to work right on that afternoon; it was on Friday night that they began to work bad.

1328. Can you tell us anything about the practice of the other machines, No. 5, for instance?—That same day the pins worked so badly that one of them pulled clean out of the block in which it was screwed; it pulled right out of the thread.

1329. Was that reported?—Yes, and the man went down to No. 1 machine, that was in the night, if I remember; the next day the machine had new pins put in.

1330. With regard to Nos. 2 and 3 machines, were you aware of anything going wrong with them?—Only the pins working bad.

1331. In what way; did they work hot?—They worked hot, and they will work hot if you cannot get water down.

1332. Have you known them to work hot?—Yes, on No. 2 machine.

1333. How hot?—So hot that the man had to have a wiper to handle them with.

1334. Have you at any time made any report about that?—No, it was not my place; I was not at work at that place.

1335. Did you think the heat of the pins was attended with danger?—I did not think they would get hot enough to cause an explosion.

1336. Did you see anything in this house to lead you to believe the machines were dangerous?—I never thought anything about it except on the Friday before, when it was spoken about.

1337. Who spoke about it?—Myself and Carr, who was working at the same end of the house on No. 5 machine, he said he should not be surprised if there was an accident with the pins.

1338. Did he convince you that there was any risk about them?—No, we were both talking about them.

1339. Did you say anything to the foreman about your fears?—We did not take much notice of it.

1340. But if you thought your life was imperilled would you not speak about it?—(The witness gave no answer.)

1341. Who had been working on the No. 2 machine up to the time of the explosion?—They had been chopped about, and then Brace was on it a little while.

1342. Did you hear him say anything about his machine?—He complained about the pins running bad.

1343. When did this conversation take place; did you talk about it in the shoe hole when you were changing?—I cannot exactly say where it was, but it has been spoken about.

1344. Was the foreman present when you were speaking about it?—He had heard the complaints, and I know he has worked hours by himself in trying to get the pins to go.

1345. By himself or with the fitter?—With us. If you could not get them to go there was a pair of pin pliers for unscrewing the nuts.

1346. That he did with you and other men?—Yes, on No. 4 machine.

1347. Was the fitter present when he was doing that?—No.

1348 Was the house cleared of powder?—No.

1349. Was the machine cleared of powder?—Yes, the hopper.

1350. Were the bushes clear?—Yes.

1351. But there might be some powder in No. 5 machine?—Yes.

1352. Was some force used to remedy those defects?—Yes, you must force them.

1353. Where did you take your meals?—Some in the shoe-hole and some in the dining room.

1354. Where did you heat your tea?—In the dining room.

1355. Did you bring the heated vessels down into the shoe-hole?—We had an ordinary quart can and the boiling water is kept up there.

1356. You did not put the can on the fire to boil the tea?—No.

1357. Did the men bring plates and things of that sort for their dinner?—Yes, they brought the plates and knives in their baskets.

1358. Did they do that in the shoe-hole?—They very rarely used a knife in the shoe-hole.

1359. Did you ever see a knife used there?—Yes.

1360. Have you ever seen them take their meals in the cam house itself?—Never.

1361. You are quite sure about that?—Yes.

1362. Have you ever seen any of the meal things taken into the house?—No.

1363. You had, I suppose, to wear fasting cloth clothes over your other clothes?—Yes, over our old clothes.

1364. Where did you keep your old clothes?—In a cupboard in the wash-up house.

1365. Has each man a cupboard?—No, there is one between two men.

1366. Who keeps the keys?—Some of them have neither locks nor keys.

1367. You were not allowed to have pockets in those clothes?—No, no pockets and no metal buttons.

1368. How did you keep your trousers up?—Some wore belts and some wore bone buttons.

1369. Who saw that you changed your things there?—There is a special man in charge of the wash-up house.

1370. How many men were there in the wash-up house at one time?—Sometimes as many as 200, in the large wash-up house.

1371. Would it be possible for the man in charge of the wash-up house to see that every man changed his clothes there?—He would walk up and down, but he could not see every man.

1372. Was there any arrangement by which the men had to pass him to show that they had changed; for instance, had they to pass through a turnstile or anything of that sort?—No.

1373. Whose place was it to inspect the men's clothes?—According to the rules, I think it is the foreman's place to read the rules and search the men once a-week.

1374. Have you been searched by the foreman?—Yes.

1375. Where did he search you, in the shifting house or in the powder house?—I have been searched in the shifting house, but not in the powder house.

1376. By Ephgrave, I suppose?—No, I have never been searched by him.

1377. How long had you been with him?—Eight weeks.

1378. And he never searched you during that time?—No.

1379. Nor anybody else?—No.

1380. If you had had a pocket in your clothes no one would have known it?—That is so.

1381. Do you say you think they ought to search men once a-week?—That is one of the old rules, I believe.

1382. Where would that be?—In the old rule book.

1383. Does every man get a copy of that book?—No, but I have seen them about in the different houses.

1384. Have you ever known men to have pockets in their underclothing?—No, but I believe one or two have been caught lately with pockets.

1385. In the danger buildings?—I cannot say that.

1386. Have you ever had pockets in your clothes?—No: I have had them either cut out or sewn up.

1387. Have you been searched by the other foremen you have been under?—Yes; if they do not actually search, they ask whether you have certain things.

1388. Do any of them do it every day?—No, I think that is not required.

1389. Or every week?—I have not been searched half-a-dozen times since I have been in the place.

1390. Who read the rules over to you when you first came in?—Mr. Findlay only said that we were to have no pockets and no buttons.

1391. Have the general rules ever been read over to you?—I had the main ones read to me out of a book.

1392. You are not familiar with this particular set [showing witness a copy of the general rules]?—Only by seeing them posted up about the factory.

1393. Do the men study them carefully?—I cannot say.

1394. Do you study them yourself?—I have read them, but I cannot say that I have studied them.

1395. Have you ever known a case of smoking in the factory?—No.

1396. If you saw a man smoking what would you do?—Clear out of it pretty quick.

1397. Would you report it to anybody?—Yes.

1398. Then you did not think the danger in the machines was sufficiently great to induce you to "clear out"?—No.

1399. You did not make any representation that you thought your life was imperilled by the defective character of the machines, did you?—No.

1400. Did you think it was?—They were certainly working very bad, but we did not know what heat they would run to before exploding. In fact, when you are working with the machines in that house, it would not do to think about those things.

1401. *The Chairman.* You had three mates with you between the Friday and the Tuesday?—Yes, one was not with me for more than two hours. I think that was because one of the others lost two or three hours in the morning.

1402. *Colonel Lloyd.* When you say you have been searched only six times, does that include the searching by the police at the gate?—No, they very often search you; you do not go a week before being searched two or three times. Every morning they search so many.

1403. Did you ever know of a file being used in the house?—I saw one used out on the edge of the platform, that is the only place.

1404. What was that being used for?—I think the fitter was filing a charger which cut into the bed of the machine.

1405. You saw that done yourself, I presume?—Yes, the fitter was on one platform and I was on the other.

1406. Were any precautions taken to remove the filings afterwards?—The platforms were washed down.

1407. Are they continually being washed down?—Yes, several times a day.

1408. Have you ever known of a file being used inside the house, either by the foreman or the fitter?—No.

1409. Have you ever seen the fitter making any alterations in the machines when there was powder in the house?—No.

(*The Witness withdrew.*)

Mr. Cyril Wraighte, *examined.*

1410. *The Chairman.* You are employed as a workman in the Royal Gunpowder Factory at Waltham Abbey, I believe?—Yes, I am employed as a skilled workman, and I have been there since 1879. I have worked in almost every danger house in the place. About four years ago, I was working at No. 2 cam house on the Lower Island. I have also worked in No. 1 house.

1411. *Colonel Majendie.* Have you had any experience of these machines since you left No. 2 house?—No personal experience.

1412. You cannot, therefore, tell us anything about the recent condition and working of the machines?—I believe they were working in the same condition as when I left.

1413. How do you arrive at that conclusion?—By looking at the machines when I have been passing by.

1414. Was there anything in the working of the machines at the time you were there, which was other than satisfactory?—Yes, when the pins were put in new they fitted so tight in the plunger that you could not get any water down them; we then had to press the water by a squirt can under the bush block. Sometimes, too, the plungers and pins could not be washed out.

1415. Would there be powder there?—Yes, encrusted in them.

1416. How would those incrustations be got away in the long run?—Only by the wear.

1417. Was any attempt made to get them away; did you or anybody ever try to get them off?—Only by washing them, as the pins became worn the water would pass down between the plunger and the pins.

1418. You never saw any mechanical means employed to remove those incrustations, did you?—No, sometimes we would unscrew the pin fastened at the bottom and work it up and down in the plunger, but still we could not get the water to pass down these pins.

1419. You say "we," who would that be?—The workmen employed.

1420. And the foreman?—No, only the workmen.

1421. Did they do that because the foreman told them?—They did it as a practical thing.

1422. Was it according to regulations?—According to the master worker's orders.

1423. Written orders?—No, only verbal orders.

1424. Was that consistent with the written orders?—We have no written orders in regard to cleaning the machines.

1425. Have you any orders relating to the treatment of a machine when it becomes defective?—No.

1426. Are you sure of that?—Yes. As regards a broken plunger or the bearings getting scored, as the machine is unable to proceed, the matter is reported to the engineer, and the machine is stopped. Sometimes a plunger gets compressed, and sometimes the top plunger gets plugged with part of the film which gathers on the pins.

1427. Who would attend to those matters?—The workmen.

1428. I presume those would be defects?—Yes.

1429. Do you mean to say you have never seen any orders forbidding workmen to interfere?—None.

1430. Are you familiar with the orders posted up in the house?—Yes, but the only order posted up in the house says, "Visitors are forbidden to touch the machines."

1431. Are not these orders posted up in the house [handing witness a copy of the cam-house rules]? Have you ever seen those before?—No, I have not.

1432. You are quite sure of that?—Yes.

1433. Have they ever been read to you without your seeing them?—No.

1434. When you first entered the factory were any rules read to you?—I was supplied with a copy of what was called the old rule book, but those books have since been abolished; we had to give them up. In Mr. William Adams's time the rules had to be read to the men every week, at least, but that was discontinued when Mr. Findlay became master worker.

1435. Where are you working now?—In No. 1 press house.

1436. How long have you been working there?—Since 4th December.

1437. Are there any rules posted up there?—Yes, as to the quantity of powder in the house; they have been posted there since the time of Colonel Hay.

1438. Are these rules posted in the press-house [handing witness a copy of the press-house rules]?—Yes, I think those are the exact rules.

1439. Have you had an opportunity of visiting No. 2 cam-house lately?—No, I have been kept away from visiting the lower part of the works since the accident.

1440. But before the accident?—It is six months ago since I was there.

1441. Did you look into the house then?—Yes, I walked into both houses.

1442. And did not notice these cam-house rules?—No.

1443. You cannot say they were not there?—I could not swear they were not, but if they had been there I should probably have seen them. When I was in the cam-house the last time I passed a remark to the man who was there upon the dirty mats in the shoe place.

1444. Whereabouts was that?—There were four doors on the west side of No. 2 cam-house, and under those doors were four recesses, about 4 feet square each, and in those recesses there were dirty cocoanut mats. [The witness, by means of the plan, pointed out the positions of these recesses and mats which were used by the visitors and Officers, and also the position of the step and mats used by the boatmen. *See* Appendix I.].

1445. Was that mat there when you were there?—Yes, and it was there right up to the time of the explosion.

1446. I thought you were not in this house?—No, but I asked the question.

1447. When, and of whom?—After the explosion, and of Mumford and some of the relieving gang.

1448. Where there any other steps?—Yes. [The witness pointed out where the other steps were, and said there were no mats there. *See* Appendix I.]. *Here* there are some wooden platforms, which, I believe, should be covered with leather because of the rule that no gunpowder should be rolled wood to wood, but there was never any leather issued out for covering them.

1449. There would be no object in having cocoanut matting there, I suppose?—No, because that part was supposed to be clean.

1450. You say "supposed to be clean," have you any reason to suppose it was not clean?—Yes, the place was not covered, and a duck, or a fowl, or a cat, or anything might go over it.

1451. Where there any ducks, or cattle, or sheep, about the factory?—No.

1452. With regard to *this* platform [pointing to the outside platform shown on the plan, *see* Appendix I.], was it not kept clean and swept?—Yes, but the only light afforded to that platform was from *here* [*see* spot marked M on plan, Appendix I.].

1453. Therefore in the night time you could not see whether it was clean or not—No.

1454. You are working in a danger building now, are you not?—Yes.

1455. What clothing are you working in?—We provide our own underclothing, and we have what they call a fire-proof smock and overalls.

1456. Do you change in the shifting house?—Yes.

1457. Who sees that you have not got any pockets in your underclothing?—That has been a neglected thing for some time past, but since this explosion the foremen have asked the men to let them search them, to undo their smocks and overalls, and to let them see what they have underneath.

1458. Do you say that was not generally done before this explosion?—That was not generally done before the explosion. The foreman would merely say, "I suppose your clothes are all right."

1459. How often?—They would sometimes run for two or three months without asking at all.

1460. Where would he say that?—In the shoe place, not in the shifting house.

1461. When you were working in this house, under whom did you work?—Adams.

1462. Did you ever work under Bailey?—Yes.

1463. What was Bailey's practice about searching?—He always seemed a very careful young man, and took a great interest in the work, though he was rather fidgety at times.

1464. Did he search you?—Yes, I have been searched by Bailey.

1465. It is four years ago since you worked in the house, and you have spoken of some defects in the machines at that time, but were there any defects which caused you to be apprehensive of accidents?—Yes, on one occasion I was working in No. 1 cam house, and one of the bottom plungers became compressed. It was our duty to loosen that plunger with a steel plunger spanner, and put what we term half-liners in. The pin was still in the plunger, and we put the half-liners in, one on each side, and while in the act of unscrewing the plunger the spanner slipped and struck the iron cylinder of the machine, and sparks flew from it.

1466. Was there any powder in the machine?—In the hopper, but none in the machine. Powder in the hopper, powder on the table, and powder in the barrel at the back.

1467. Did you report that?—Yes, to Samuel Adams,

the man in charge, and he turned round and told me he did not believe it. I then asked Mr. Turnham, chief foreman, to bring it before Mr. Findlay, so that Mr. Findlay could bring it before the Superintendent. I heard no more about it, but the next time I met Mr. Findlay I asked him if, when these steel spanners were used, he would make an order that all powder should be removed from the house. To that Mr. Findlay said it would involve too much time.

1468. Did you remain working there?—When the tools were going to be used, I took my dirty boots, put them on and walked away from the house. On another occasion I was in the south end, working at No. 3, when a man at No. 2 asked for the steel spanner to be passed to him, and just then Mr. Turnham entered the house. I said "Are you going to use the spanner," and he said, "Yes." I said, "I am going out," and I walked to the north end. Mr. Turnham followed me, and said, "What do you mean by going out of the cam house; if I were timid, like you, I would go out of the factory altogether." I asked him if he would give me an order, and he said "No." I then turned to No. 4 machine, and picked up two iron spanners, and asked him if they were proper things to be used in a powder house. He said I was there to do work, and not to dictate. Those spanners were lying about. If anyone had gone into No. 1 cam house they would have noticed some copper nails which I drove into the wood work on purpose to hang the spanners on.

1469. Could those spanners have been used while the machines were in motion?—Yes. One kind of spanner is for the plungers, but the other kind is made to fit the nuts of the studs which hold the bed to the cylinder. I have known those studs to break off short. Owing to the vibration of the machines the nuts get loose, and as the bottom plungers were descending I have known the spanners to be used to tighten the nuts.

1470. Were those steel spanners?—Yes, they were when I was there.

1471. Where did you take your meals?—When I was at the cam house we went to the dining-room.

1472. Did you ever take your meals in the cam house itself?—No.

1473. Or in the shoe room?—No.

1474. Do you ever see people having their meals in the cam house?—No.

1475. Why did you ultimately leave the cam house?—I think it was for complaining about the manner in which those steel tools were used. I was shifted to the breaking-down house, and while there I complained of the dangerous manner in which they carried on their work. Maynard was then shifted to the breaking-down house, and I took Maynard's place in the press house. We had not in that house sufficient time to do the work properly, but we did six pressings instead of seven for a week, and then we went to Mr. Findlay, and while trying to explain the matter to him he said, "Wraighte, you are the ring-leader in this," and I was then suspended from the powder [illegible]. Mr. Findlay then gave me an order to go to No. 3 breaking-down house, and when I got there I asked the foreman how he was working. I said, "Are you working with flaps up or down?" he said, "Up, by Mr. Findlay's orders." I said, "Are you working with the governors *in* the clutch?" and he said, "Out." I then said, "You must put the flaps down and the wheel in clutch, or I shall not start work." A man then came in and said he had orders to stay there and do double duty; I said, "Very well, I am going down to the office," and when I got there, I asked why I was picked out for the breaking-down house, as there was another man willing to work there, and Mr. Findlay knew I had a dislike to work there, on account of the conditions under which they were working. Mr. Turnham said Mr. Findlay was determined I should go there. I said, "I am willing to go there or to any other house if you will work according to regulations, but if not, then I said I am right to refuse." I afterwards went before Colonel Barker, who suspended me for what he called intimidation, and I was suspended from the black powder for six weeks, and until the arrival of General Noble. During the time I was suspended I was put to all the dirty work that could be found for me. I was even put to digging holes in the mud. With regard to the machines, I should like to say that when I was employed with the Nos. 1 and 2 cam machines, the pins became very much worn, and so affected the prisms [the witness described the interworking of the pins and plungers and bush-blocks].

1475*a*. Did you call attention to that?—Yes, and if it were daytime the engineer would come and put another pin in.

1476. And at night?—If we could not find an old pin ourselves the machine would stop.

1477. Then the pins were sometimes put in in the night time by the men themselves, irrespective of the fitter?—Yes.

1478. You have seen them so put in?—Yes.

1479. And put them in yourself?—Yes.

NOTE.—The Witness subsequently, *i.e.*, on 8th February, 1894, wrote to the Secretary, "I beg to state that H. Skinner, the only uninjured man, stated in the presence of J. Cole, S. Mumford, and myself that the steel spanner was fetched from the north end by one of the deceased workmen to the south end, to be used on No. 2 machine on the night of the explosion."

(*The Witness withdrew.*)

SATURDAY, 3RD FEBRUARY, 1894.

Present.

Lord SANDHURST, *Chairman.*

Members.

Sir F. A. ABEL, Bart., F.R.S.
Colonel V. D. MAJENDIE, C.B., Her Majesty's Chief Inspector of Explosives.
Colonel F. T. LLOYD, C.B., R.A.

Mr. R. H. BRADE, *Secretary.*

Mr. GEORGE EPIGRAVE, *examined.*

1480. *The Chairman.* You are a foreman in the factory at Waltham Abbey, I believe?—Yes, in the cam-house.

1481. For how long have you been a foreman?—I have been a foreman in the prism powder houses for about 12 years, but only the last 9 months in the cam-house.

1482. How long have you served in the factory altogether?—About 20 years.

1483. Have you worked on the day and night shifts?—Yes, my duties were opposite to those of Bailey.

1484. *Colonel Majendie.* When were you last on night duty, the week before the accident?—Yes.

1485. Was there any difference in the mode of carrying on the night duty as distinct from the day duty?—Not the slightest difference.

1486. In your opinion, can the work be regarded as being as satisfactory in the night as in the day?—Yes, if we get a good enough light.

1487. Was your light good?—Yes, especially since the last dynamo was put in.

1488. At the time of the accident, was it a good light?—Yes.

1489. Was it all external lighting?—Yes, from outside the windows; we also had two little hand-lamps.

1490. Were they much used?—No, except when we had to adjust a machine, and then I had one of the men to hold the lamp.

1491. You did not use the electric lamp for illuminating the buildings, but only for a definite purpose?—That is so.

1492. And you put it out directly the work was done?—Yes.

1493. Was there one of those lamps for each compartment?—Yes, and there was a third one for the boatman for fetching the water with.

1494. It was your duty, was it not, to search the men under your charge?—Yes, occasionally, and to read the rules to them.

1495. What did the searching consist of?—Turning their smocks up and seeing what sort of belts they had on, and also seeing that they had no iron buttons.

1496. Were there any reports made by you about that to anyone?—No, I made no reports. We all stripped together in the wash-up house, most of the men had been working for some years and they well knew what the penalty would be if anything was found on them.

1497. In the old clothing the pockets had to be either cut out or sewn up?—Yes.

1498. In the course of time that old clothing wore out, did it not?—Yes, and we had to get fresh.

1499. As a matter of safety, was the fresh clothing inspected and marked?—No, it was left to ourselves.

1500. And would you see that the substituted clothing had no pockets, or that the pockets had been sewn up?—Yes.

1501. Who looks to the sewing when it comes undone?—The men themselves; there are needles and cottons served out in the wash-up house and there are plenty of bone buttons from the lasting clothes. No iron buckles or buttons are allowed.

1502. Was the system of searching the same at night as in the day-time?—Yes, but we did not trouble much about it on night duty, we generally did the searching in the daytime, every Monday morning, and as we took turn and turn about for day and night duty that made the searching only once a fortnight. We used to strip, about 20 in one compartment, and we should round on a man who did not take his clothes off.

1503. Have you ever known them do that?—Yes; the men have complained to me and to others.

1504. During your 12 years' service as a foreman, I presume you have searched a good many men?—Yes.

1505. And in that time have you ever found men in the danger buildings with pockets in their clothing?—No.

1506. Have you ever found them with their pockets unsewn?—No, but I have found them with their pockets cut out.

1507. That you do not object to?—No.

1508. Were the machines working satisfactorily when you left on the evening before the accident?—Yes, I left them in good order.

1509. Have you found the pins sometimes break?—No, not break, but they would sometimes pull out from the bottom when the powder got clogged, and when they were new we had great difficulty in clearing them. We used hot water to try and clear them, but when they were new they fitted so perfectly in the bushes that the water would not go down. We had new pins on the Friday previous to the accident, but we had had two days and two nights with them, and so they were in good working order on the Tuesday night.

1510. Do the plungers go wrong sometimes?—Yes, they compress slightly, and go down. Sometimes, if the powder stands long in the magazine, it will get a little lumpy, and if you get lumps in the machine they will compress the bottom plunger. A plunger was broken on the Tuesday morning.

1511. Was that replaced?—Yes, and we started working about half-past 10.

1512. Who replaced it?—Johnson, the fitter.

1513. Were the repairs to the machine always done by Johnson?—Yes, but we packed the plungers ourselves, and tightened up the nuts.

1514. I understand you have spanners for the purpose?—Yes, three little steel spanners.

1515. Where were they kept?—In a drawer or in a cupboard.

1516. Would you tighten up the nuts?—If I was about I should do it. Every time we washed the machines it was the duty of the men to feel the top plunger and see if it was all right, because the action of the machines sometimes worked the screws loose. The screws generally wanted only half a turn, and if I happened to be down with No. 1 machine the man working in front of the machine being washed would give the screw half a turn.

1517. Could any work of that sort be done while the machine was actually in motion?—No, a man would be liable to get his arm smashed if he tried to do that.

1518. Is there any work about the machine which could be done with the spanner while the machine is actually running?—We might use the little spanner in adjusting the machine for the densities; we could do that, but we do not do it.

1519. Have the chargers, as a rule, worked satisfactorily?—They work with difficulty at times. The grain of the brown powder is harder than the E.X.E.; it is so hard that sometimes it cuts into the metal of the charger, and if it gets under it we have to take it away and clear it out.

1520. Have any complaints been made to you by the men with regard to the working of the machines?—Only about the pins; we talk about them amongst ourselves.

1521. Have they ever expressed any opinion about the machines being dangerous?—No.

1522. Have you had any such idea yourself?—No.

1523. Have you ever seen anything in the way of an accident with the machines?—Only when a machine has smashed up; that is, when a man has neglected to watch it.

1524. How would that happen?—If water gets on to the charger, the powder gets clogged, and stops it. The man's duty is to see that the charger comes over, and if the charger gets clogged on a damp day, and the prisms are not pushed off and the men are not watching, then the top plunger comes over and pigtails the pins, and smashes up the whole thing.

1525. Does that often happen?—No; and since they have given men a week's holiday (that is, suspended them) we have had nothing of that sort. If anything happened, it would happen when they have pigtailed the pins, and when they are so hot that they cannot hold them.

1526. In order to ensure the satisfactory working of the machine, a man must keep his attention on the machine?—Yes; there is really no work about it, a child could do the work.

1527. *The Chairman.* You say the pins do run hot?—Yes; that is when they neglect to watch the machine, and when the pins get pigtailed.

1528. *Colonel Majendie.* Do any of the bearings at any time work hot?—No; a grain of powder sometimes gets into the bearing and (what we call) "mucks" it, and we have to get it out.

1529. Is there any place for putting the cotton waste into?—Yes, we have a cupboard for that.

1530. Where, in the shoe-hole?—We put the clean ones in the shoe-hole, but the dirty ones we put on the tables at the side. A man has six cloths for each machine.

1531. Is there any place outside in which to deposit the dirty ones?—Yes, it is a kind of a square tank outside the door.

1532. When is that used?—Every Saturday; we clear out the dirty wipers on Saturday.

1533. Where do the men have their meals in the night time?—Sometimes in the dining room, and sometimes in the shoe-hole. The lights go out sometimes at half-past 10 and sometimes at 11, according to the work.

1534. Which was the commonest thing at night?—Half to the dining room and half to the shoe-hole.

1535. Is the shoe-hole clean?—Dirty, with big boards about. [The witness then pointed out, on the plan, the position of the shoe-hole, which, he said, was not large enough to accommodate more than about five men at a time. In the shoe-hole were several movable boards, which the men used for standing on, in order to keep their shoes clean when coming out of the cam house. The witness also pointed out that on the shoe-hole side of the house there were clean mats, whereas on the other side of the house there were dirty mats.]

1536. A man coming in at *this* door (*i.e.*, one of those marked C, D, E, or F, on the plan, Appendix I.) would come with his dirty boots?—Yes; but those doors are only for the officers who would look in to see how we were going on, without changing their boots.

1537. What is the object of the clean mat for the shoe-hole?—I cannot say.

1538. When a man brought powder in *there*, (*i.e.*, at the spot marked B^1 on the plan, Appendix I.), was there any difficulty in lifting it up?—Yes.

1539. Did you ever see it slip and go back again?—I cannot say; I dare say it has happened, but those men were well up to their work, and they could easily hold the barrels.

1540. They were a good weight?—Yes, but there are others that are heavier; when the barrels go out they weigh 120 lb.

1541. Do you think it is a good arrangement to have this step *here*?—No, but I suppose that was there owing to the construction of the house.

1542. Have you, in the course of your experience, known of a case in which matches were found on a man in the factory?—Not with black clothes on. About 15 or 16 years ago some matches were found on a stoker named Powell; that was in Mr. Adams's time. Those matches were found in the man's coat pocket hanging in the stoke-hole, and the man was discharged. I have never known of anything explosive being found on any one in the powder house.

1543. Do you think men would "round" on one another if they caught a man with those things in his possession?—Yes, the men working with us know what is right.

1544. But even experienced men sometimes do imprudent things?—Yes.

1545. At any rate your point is that the other men would at once call attention to any such thing?—Yes. Bailey was a wonderfully cautious man about those things, and that was why some of the men did not like him.

1546. Had you known Bailey for some time?—Yes.

1547. And could you give him a good character?—Yes, he was a good steady chap.

1548. Have you ever known a case of smoking on the works?—No.

1549. Not in the dining room?—No, if such a thing happened it would be reported in a moment.

1550. We understand that someone comes round to these houses at night?—Yes, Collop comes round when my gang is on, and Beales comes round when Bailey's gang is on.

1551. How often do they come round at night?—Collop comes round about 9 o'clock at night, he looks in at the door and asks if it is all right, and we say "Yes," and then he goes away. He does not understand about the work; if a machine goes wrong we send for the engineer.

1552. Was anybody in the habit of coming round in the small hours of the morning, say, about 2 o'clock?—No, not often, except perhaps Beales would come down when he wanted to take a sample.

1553. Would Collop sometimes go round one way and sometimes another?—Yes, but he generally came about 9 o'clock.

1554. Has he ever come twice?—Yes, about 4 o'clock in the morning.

1555. Did Beales do the same?—Yes.

1556. You could not be sure when he had come once that he would not come again?—No.

1557. Would he come twice generally?—No, more often once.

1558. Would anybody else come round?—No, no one, except perhaps Captain Nathan.

1559. Did anybody ever, whilst they were at work, come and look at the men's clothes, that is, anybody other than yourself?—I believe Captain Nathan has done so. I heard that he once found a man with an iron hook on his clothes..

1560. Did you know the men who were killed?—Yes.

1561. Were they a good lot of men?—Yes, they had worked with me.

1562. Have you ever heard of a case in which sparks struck from the machinery in the house?—No, nothing beyond what I heard Wraighte said at the inquest.

1563. Did you hear of it at the time?—No.

1564. Would anything of that sort be talked about in the factory?—Yes; we have all laughed at the thing in the factory, you cannot get power enough on the spanners for that.

1565. But still, I presume, you would not dispute the fact that if you struck the two substances together you would get a spark?—Yes, if it were rough stuff, but not with a malleable iron thing like that.

1566. Have you in your own mind arrived at any conclusion as to the probable cause of the accident?—No, excepting that a match, or something combustible, got into the powder.

1567. How could that happen?—I do not know; there have been cases in which they have found matches in the powder. I believe they have a prism in the laboratory in which is shown a match cut in two.

1568. Have you formed any opinion as to where the accident originated?—According to the men who died, it originated at No. 2 machine, either in front or at the back; Clayden told me it was his machine, and he was in front of it at the time, and he was just in the act of taking the six prisms off to put on the rack. Directly he has packed them, he turns his head round for six more, so, if he was in the act of packing them, that machine, was actually pressing; he said he saw the flash sideways.

1569. Was he turning to the left?—Yes. [The witness then showed, on the plan, the position of Clayden's table, and how Clayden was placed in reference to the machine and the lever. *See* Appendix I.]

1570. Did Clayden say the flash came from the machine?—No, he said he believed it was his machine.

1571. Did you ask him at all whether you saw anything occur *here* [pointing to the spot where Watts's body was found, *see* plan, Appendix I.]?—No, he said he got out of the door as soon as he could, and jumped into the water.

1572. He was looking to the north, and the flash came from the east?—Yes. *This* (*i.e.*, No. 2 machine) was the machine where a plunger was found broken, but we do not know where the thing fell from that was there, or whether it caused the breaking of the plunger.

1573. Was that house lined?—Yes. There was a band carried up to the ceiling for the purpose of bringing up the top blocks of the top plungers; that band ran on a pulley fixed in the lining of the ceiling, and over the pulley there were pieces of wood fastened so as to prevent anything falling down from the roof into the machine.

1574. Was that screw sufficient to cause the breaking of the plunger?—Yes, but I do not know how it came there.

1575. Did you visit the house after the accident?—Yes, about 6 in the morning, but I was not allowed to go in.

1576. You are not aware that other screws were found there?—No.

1577. The wood lining was all burned, was it not?—Yes.

1578. Under those circumstances, it would be easy enough for things to fall?—Yes.

1579. Have you ever known anything to fall under ordinary circumstances?—No, never.

1580. From your recollection of the arrangement of the roof, do you think it would be possible for anything to get through, would not the wood lining prevent anything from getting down at all?—I think so. There is no evidence to show where the screw or nail came from, it might have been in the powder, and when the man shot it into the hopper, it fell over the top.

1581. But if the screw were of the same nature as a number of others that were found in the house, the presumption would be, would it not, that it came from the roof?—Yes.

1582. Do you think it is more likely that the accident happened *there* than *here* [pointing to the plan, firstly, to the spot where Watts's body was found; and secondly, to the front of No. 2 machine where Clayden was. *See* Appendix I.]?—There was nothing *there*.

1583. Was not Watts rolling in a barrel?—Yes, but he could not get pace enough on the barrel, there was hardly room to move. [The witness then explained the positions of the different machines, and other articles in the house.] Watts could not get up even a snail's pace at *that* point.

1584. Do you know where Watts's body was found?—Yes.

1585. The other men came out at this door (marked J on plan, Appendix I.), did they not?—Yes, and so got the benefit of the boat. [The witness then explained how the explosions affected the different men, and showed that in rolling his barrel along Watts would be practically over the powder.]

1586. The presumption is that Rudd and Rudkin were at their machines?—Yes, they probably sat down and watched the chargers.

1587. Close to the door?—In front of the weights and near the door.

1588. Were they nearer the door than the weights?—Yes.

1589. That hardly agrees with their positions as marked on the plan?—That represents where they should be, but directly they fill the hopper they sit down *there* (*see* spots marked P_2 and P_3 on the plan, Appendix I.) and watch it.

1590. How long would the hoppers last?—About a quarter of an hour or 20 minutes.

1591. During that time they have nothing to do?—They have no laborious work to do, only to watch the machines. It is just as likely that those two men were sitting on the seats *here* [pointing to the spots marked P_2 and P_3 on the plan where the seats, or barrels, would be. *See* Appendix I.]

1592. And if a man were rolling in a barrel he would pass between them and the machine?—Yes.

1593. *The Chairman.* You say that when the pins are put in first they work very stiffly?—Yes.

1594. Have you ever seen any accident in consequence of that?—No, only by pulling out the block.

1595. How often are the cleaning cloths served out?—When a foreman wants any, he sends up to the stores for them; we can always get them when we want them.

1596. You say that the accident may have been caused by something in the powder?—Yes.

1597. Do you mean in the barrel or in the machine?—It got into the powder, and then into the machine.

1598. You mean in the powder in the machine, and not in the powder in the barrel?—I do not think it was caused by rolling the barrel along. It was a wet night; the platform is exposed to the weather, and a man rolling a barrel along there would get the bottom of it all wet. The reason why we do not have leather along there (*i.e.*, the platforms) is because leather would soak up the water, and keep the barrels always wet.

1599. Are the boats allowed to go alongside other

houses, the press house, for instance?—No, not while the men are working, nor at the granulating house.

1600. *Colonel Lloyd.* When you have been examining men in regard to their clothes, have you ever found such things as pocket-knives on them?—No.

1601. Would a man carry such a thing as a knife in his shirt-front?—Anything of that sort a man would carry in his basket.

1602. Would a man have a dinner-knife in the shoe room?—Yes.

1603. Would there be any objection to that?—No, so long as he kept it in his basket.

1604. Have you ever known of a knife being brought into the house?—No, only by the fitter.

1605. Do you see any objection to having the steel spanners cased in leather?—You could not case the working part, and when the plungers have been a week at work the action of the powder and the water makes the screws fit in so tight that no metal but steel would be of any use to move them.

1606. Could not you have a smaller spanner?—No, you could not get them in. There is a little slot of only about ½ inch to put the spanners in.

1607. And no addition of leverage would be of any use to you?—No.

1608. Do you see that any danger can arise from using steel spanners?—No, not unless you use them roughly. Wraighte says he used a spanner, but he had no business to do so. It is a foreman's work to pack a plunger; all a man has to do is to give a screw a half-turn, and he can do that with his thumb if he likes.

1609. Do you see any way in which the machines could be modified, so that a metal spanner could take the place of the present steel spanner?—No, I do not see how that can be done, because the powder and the water together will corrode anything.

1610. Did you see Rudd and Rudkin before they died?—Yes.

1611. Could they give you any account of what happened?—No, neither of them; they simply said they saw a flash, and nothing more. Clayden was the only man who could give a clear idea of it. It was such a low ceiling that it was like an oven when the fire went.

1612. *Colonel Majendie.* Did Rudd and Rudkin say where they were when they saw the flash?—No, but they talked of being in the house and Jennings, too. He might have escaped a lot, if he had had presence of mind, but instead of going to the door where Skinner went, he went round to the other side and fell over the shafting, and he got the benefit of the boat.

1613. *Colonel Lloyd.* When Watts brought his barrel of powder into the house, were there any other barrels of powder already there?—No, because we do not call for any more barrels until we want them; sometimes we let the hoppers go three parts empty. We blow a whistle when we want them to bring us up some powder.

1614. How many barrels of powder would a powder boat have in it when full?—About eight. On Monday mornings they bring up nine barrels, that is allowing one for the hoppers, but after that they bring up only eight.

1615. Do you say there has been no accumulation of dirty cloths?—Yes, because if Captain Nathan finds any dirty cloths in the house on a Saturday, we get into a bother.

1616. How many would you use in a week?—Three dozen.

1617. Then there might be three dozen about on Saturday?—Yes.

1618. *Colonel Majendie.* They would not be all oily ones, would they?—No, only eight of them. They are put outside in an open tank, and rain and water and anything can come upon them; the tanks are half full of water sometimes.

1619. How is the powder put into the hoppers?—By means of a bowl, they empty about three parts of the barrel till there is only about 20 lb. left in it, and then they take the barrel in their hands and tip the rest into the hopper.

1620. There is no searcher above the hopper, is there?—No, but the chargers are made so sensitive that if a bit of wood, only half an inch, gets in there it stops the charger, and so will a bunch of hairs from a hand brush.

1621. Then could a screw get through?—No.

1622. A little particle of a grit might?—Yes, or even a piece of a screw.

1623. With reference to these cam-house rules, are they the only ones posted up in the cam-house?—Yes, but every man has a book of general rules, and every house has its own rules. In the old thick rule books I think you will now find the general rules.

1624. You read the rules to the men?—Yes, once a fortnight, on Monday mornings.

1625. One of the cam-house rules says, "When starting afresh the machine should first be run several times with the hopper empty, and stopped, so that the chargers are over the dead plate," is that to see that the machine is working all right?—That means after a machine has been repaired. When we go away we leave the hoppers empty and the machines thoroughly clean; the men who come next set the machines running and they oil up; then they stop and fill up the hopper and then they carry out this rule: "After any stoppage of the press from whatever cause, the grain in the charging rings should be partly taken out before the machine is again started." We put a spud in and clear the thing out, so that the first prisms are wasters.

1626. No. 2 of the cam-house rules says, "Great care must be taken to prevent any undue straining of the machine, as a neglect of proper precautions has led to a serious accident." Do you know of any such accident?—No. If we find any undue straining, we at once send for the fitter; and we can tell in a moment if there is anything wrong with the machines. There are only four bearings, and if we hear any groans we can tell at once that something is wrong.

1627. In another part of the same rule it says this: "It is most important that no grain beyond the proper quantity is in the bouches when a pressing is commenced." Why is that, to prevent the prisms turning out badly?—When starting a machine, a man shooting powder in is likely to put more powder in the bushes than is needed. If you shoot it in, the powder will settle down, and in that way we get prisms that are too heavy.

1628. *Colonel Lloyd.* I presume you are perfectly familiar with the general rules?—Yes.

1629. Would you wish to see any additions made to those rules with a view to greater safety or to taking additional precautions?—No, except with regard to the machines; I should like to see some improvements made in them.

1630. Do you think improvements could be made?—Yes.

1631. *The Chairman.* Do you mean in the rules, or in the machines?—In the machines. I do not know anything about the rules, except that they should be more strictly enforced, and the men better looked after, and so on. We make no reports. I think the machines might be improved so that we could work easier with them; the pins are all the trouble. I think if the hole through the bottom block to which the plunger is fastened were made bigger there would be more likelihood of our being able to get at that part. We can clear a plunger, because there is a hole at the side; but the bottom block is more in a half-moon fashion where the pin runs through, and we cannot get at that part.

1632. Do you think there might be an accumulation of powder there that would not be cleared out?—That is where it does accumulate.

1633. Was a copy of these rules posted up in the cam-house when you were last on duty?—Yes, a copy at each end, and a copy in No. 1 house.

1634. *Colonel Majendie.* I understand from you that a man must carefully watch a machine, as the charger may not work?—That is so.

1635. Would there be any possibility of so arranging it that it would go all right even if a man were not looking at it at all; that is to say, is it possible to arrange for something to do what a man now does?—No, I think not; I think you must have one man in front and one behind the machine, so that if anything goes wrong, one of them can stop the machine. The men now do it all right; though, sometimes, perhaps, one may not watch it, and the machines themselves sometimes work beautifully, and then perhaps a charger will hang up just once.

(*The Witness withdrew.*)

Mr. JOHNSON, *examined.*

1636. *The Chairman.* You are employed as a mechanic at Waltham, I believe?—Yes.

1637. How long have you been there?—I am now in my tenth year.

1638. *Colonel Majendie.* Are you on at night?—No, only in the daytime.

1639. Are you often called by the foreman to repair the machines?—Yes.

1640. Had you attended frequently to the machines in the house that exploded?—Usually every day for one or the other of them.

1641. Had you been called there the day before the accident?—Yes, to put new plungers into No. 2 machine.

1642. What had happened to the plungers?—They had broken; that did not happen more on one machine than on the other, it was much the same all the way through.

1643. Were the plungers of the same character as they had always been?—Yes.

1644. Had you put new pins into that machine repeatedly?—Yes; that machine had been working with its pins about eight days, the other machines had had theirs in only six days.

1645. Do the pins work badly at first?—Yes, always at first.

1646. Supposing a plunger broke in a machine at night, what would happen?—They would stop the machine till the morning.

1647. Have you ever known a plunger replaced by the workpeople?—Never.

1648. You are quite sure of that?—Yes, because I have no plungers in the house.

1649. Have you ever known a machine work with a broken plunger?—No.

1650. Can they replace the pins?—No, I never leave any in the house.

1651. Where do you keep the pins?—In my workshop.

1652. Is that locked up at night?—Yes, as I go away.

1653. Is there anybody else in your position?—Only my foreman.

1654. Where was the key on the night of the explosion?—In Mr. Barker's office.

1655. Do you know that?—Yes, I found it there the next morning.

1656. Was there any work of the nature of repairs which could be done by the workpeople without calling you?—Yes, a plunger might compress, and then they would pack a liner underneath.

1657. Would they have to use a spanner to do that?—Some call it a spanner, but I call it a screw-driver, it is like an ordinary wood screw, in the trade we always call it a screw-driver.

1658. Is it not of steel?—Yes, because metal will not stand the strain.

1659. The spanners were kept in the house, were they not?—They were supposed to be kept in a cupboard in the shoe-hole.

1660. Were they to be used by the men?—Yes, because possibly a screw might get a little bit loose in the working; they would do that themselves so as to save the time and trouble of coming for me.

1661. Was there any other work which they could, or did, do on the machine?—There was just the alteration of the top cross-heads.

1662. What implements would they use for that purpose?—A spanner and a short piece of gun-metal, and a gun-metal hammer.

1663. Would they stop the machine for that?—Yes.

1664. Was there any work they could do on the machine without stopping it?—No.

1665. Have you had any complaints made to you as to the working of these machines?—No, no more one day than another.

1666. Speaking generally, were they machines people were suspicious about?—No.

1667. Were you?—No, I thought them safe. On the morning after the explosion if those machines had been cleaned out with water, I would not have minded putting powder into them.

1668. Was there not a screw found in one of the bushes?—Yes, on No. 2 machine, I saw it after it was taken out of the machine.

1669. Was it at all distorted by pressure?—Very little indeed.

1670. What sort of screw was it?—I saw it only in Captain Nathan's hands; it looked like a copper screw.

1671. Are you able to say it was not a screw from some part of the machine?—Yes; it came from somewhere out of the roof.

1672. Could the screw get from the roof while the wood lining was in the house?—No; the machines were working after the explosion occurred.

1673. Then the screw must have followed the explosion, and could not have caused the explosion?—That is so.

1674. With regard to the machines generally, you appear to consider them safe machines when they are working all right?—Yes.

1675. Do you think they are dangerously liable not to work all right?—No.

1676 Have you seen any reasons for recommending any alterations in the machines?—I have seen no cause for anything of that sort.

1677. Could anything be done to prevent the plungers getting broken, and the pins working unsatisfactorily?—No, because these are due to the pressure.

1678. You do not think they are owing to constructive defects in the machines?—No.

1679. What happens is inevitable from the nature of the work?—Yes.

1680. Could any alteration be made so as to render them less frequent?—No, we have tried all ways, but it is an impossibility.

1681. We have been told that if the man who works the machine does not attend carefully to it a charger

may not work properly, and not push the prisms forward enough?—If the charger should happen to hang up then they must stop the machine.

1682. Supposing a man's attention is called to something else, and the charger hung up, would that cause an accident?—I do not see how it can that way; a charger cannot come over a second time, because the cam that works the charger would stop it.

1683. Is there any liability to the plungers coming down and cutting the prisms which have not been pushed away, or not removed?—If a charger should not come over, and if the man did not notice it, the plungers would probably cut the prism in two.

1684. That has been done?—Yes, but it has not caused an explosion.

1685. You would not think that a nice thing to happen to a prism, would you?—It has happened three or four times without an accident; I put that down to the men's own fault.

1686. That is all productive of defective working in the machine?—Those machines would stop at once.

1687. Yes, when they discovered it; but the mischief might be done in producing this defective working?—We have had that happen many times.

1688. Bent pins are of course objectionable, and bad working?—Yes, and if they become pig-tailed, or if a charger happens to hang up, they send for me at once. I say, "What is the matter?" and they say, "The charger will not work." They empty the hopper, and take the charger off, and then if there is any fault in it I detect it. If a charger does not shove off the prisms properly that might be because the bottom plunger is rough on the face, then I have the house cleared of powder, and I replace the plunger, and they start work again.

1689. The cases of pig-tailing of the pins have been due to the non-attention of the men, have they not?—Yes.

1690. Is there means of so modifying the machine that you could be independent of the attention of the men; that is, could you make the machines do automatically what the men now do?—That was being done at the time this happened. A man may fill his hopper and walk away; the machines have now been altered to meet that.

1691. A man's attention is not constantly necessary?—Since last May, two of those machines have been repaired, and so a man could fill up his hopper and walk right away till more powder was required.

1692. *Colonel Lloyd.* That was not the case with No. 2, was it?—Yes, those two machines were repaired since No. 2.

1693. *Colonel Majendie.* Then those defects have not occurred since those particular alterations were carried out?—No, the machines were taken right out of the house when they were altered.

1694. *Colonel Lloyd.* Then those defects could not occur again as the machines are?—That is so.

1695. That is the case with all the machines now?—Yes, but No. 1 has not been under thorough repair yet; that has not been taken off its foundations, and is not right like those four were. The bearings in No. 1 are not so tight as in the others; it works automatically, and is a little out of adjustment, but nothing to make any complaints of.

1696. *Colonel Majendie.* When you carried out any repairs or alterations in the machines, was the whole house cleared of powder?—Yes, whichever end I was in.

1697. And all the other machines were cleared of powder?—Yes, washed down.

1698. And the prisms taken away?—Yes.

1699. When the men were putting liners in or making the slight alterations you have mentioned, would they clear the house?—Not for putting in a metal liner, I think; when they take the screws out the place is all swimming with water where the screws are.

1700. But there would be powder about in other parts of the house?—Yes.

1701. In the cam-house rules it says, "Great care must be taken to prevent any undue straining of the machine, as a neglect of proper precautions has led to serious accident." Can you tell us what that means, what accident?—I think that is only like a caution. I do not think there have been accidents with the machines.

1702. Do you think it would be right if it said, "Might lead to serious accident"?—It would look better that way.

1703. How long have you been familiar with those machines?—Ever since they have been there—seven years.

1704. "When starting afresh, the machine should first be run several times with the hopper empty, and stopped so that the chargers are over the dead plate," that is to see that the machine works correctly?—Yes.

1705. "It is most important that no grain beyond the proper quantity is in the bouches when a pressing is commenced"?—That is to see that they get no extra charges in.

1706. "Any defect in the machinery, or any repairs required, should be at once reported to the master worker, and to the foreman of machinery, Lower Island." Is it reported to two persons?—Yes.

1707. What is your relationship to Mr. Barker?—I am his charge hand.

1708. Suppose a pin becomes bent, or a plunger becomes broken, who would be told of it first?—I should be.

1709. And would you tell the foreman of machinery?—They would send for me; I should repair the machine, and then tell Mr. Barker.

1710. Were there any written reports of such matters?—No, I reported verbally only.

1711. "No persons, except those who are properly instructed and duly authorized, are at any time to meddle with or interfere with the machinery." What would that mean; that the workpeople are not to do anything with the machines?—I think that refers to visitors. Visitors might accidentally start a machine when it was not in working order.

1712. You do not think that forbids a man to put a new liner under a plunger?—I do not read it in that way.

1713. What does "undue straining" mean?—I think that is alluding to the chargers.

1714. What would you call an "undue strain," if you heard a machine making a noise is it to be stopped at once?—When the chargers get a little bit dirty at the bottom it takes a little more to shove them back and that might strain; they are supposed then to stop a machine and report. I think that refers only to the chargers.

1715. "Before work is commenced the foreman on duty will examine all the machinery and see that everything is clear before starting the machine." Is that the foreman of the house?—Yes, before any powder is put into the machine the foreman is to see that it is all right.

1716. Have you, since the accident, and, in consequence of any enquiries made, seen anything which would lead you to believe that the accident was due to the machine?—No.

1717. Do you believe it was due to the machines?—No, I believe they were quite clear. I have taken those machines to pieces, and found them the same as if they were in working order, bar that plunger being broken where the screw came down.

1718. And that you believe happened after the accident?—Yes.

1719. *Colonel Lloyd.* What makes you think that this screw fell in after the accident?—Because the roof fell in.

1720. But, apart from that, are there any mechanical reasons which lead you to believe the plunger broke afterwards?—Yes, from the way in which it was compressed, it seems as though it was pretty hot at the time it was compressed.

1721. Where was the screw found?—On the top of the bush block, the machine was working at the

time. [The witness then showed, by means of a diagram, where the screw was found.]

1722. Was the screw bent or sheared?—Sheared, it was in two parts and one part seemed as though it had been in the bush.

1723. You think it was the screw getting in that broke the plunger?—Yes.

1724. *The Chairman.* I understand you were on duty in the day time, but suppose anything went wrong with the machines at night, what was done then?—They would stop the machine, for repairs the next morning; there is always a spare machine in No. 1 house.

(*The Witness withdrew.*)

Mr. Findlay, *re-examined.*

1725. *Colonel Majendie.* I want, in the first place, to ask you some questions with regard to the cam-house rules. No. 2 says, "Great care must be taken to prevent any undue straining of the machine, as a neglect of proper precautions has led to serious accident," what accident does that refer to?—I do not know.

1726. Who prepared these rules?—General Noble.

1727. If there had been any serious accident, you would have known of it, would you not?—Yes, but I am not aware of any serious accident.

1728. "Care must be taken to prevent any undue straining of the machine," what does that mean?—That there must not be a greater quantity of powder put into the bouche than the charger will allow, if the chargers are allowed to stand under the hoppers for any length of time we get a little more powder than we require.

1729. *Sir F. Abel.* Do you think that conveys to the men sufficient information as to what the term "strain" might mean?—Yes, I think so.

1730. *Colonel Majendie.* "If there be any suspicion of undue straining due to any cause, the machine should be stopped, and the circumstances reported to the master worker or the foreman of machinery at the Lower Island," would it be the duty of the foreman at the house to make that report?—Yes.

1731. To one or the other?—He would go to the engineer, and not wait for me.

1732. That is to effect a repair, but apart from the circumstance of repairs, he has to make a report, has he not, under this rule, that there has been a necessity for calling in the engineer?—Yes.

1733. Is that in writing?—No, only a verbal report.

1734. There is no written record kept of repairs and alterations?—No.

1735. "No persons except those who are properly instructed and duly authorized, are at any time to meddle or interfere with the machinery," what does that mean?—That no one is to interfere with the machinery except the foreman or the engineer.

1736. "Any defect in the machinery, or any repairs required, should be at once reported to the master worker and to the foreman of machinery, Lower Island," would it be in accordance with that rule for the workpeople to do any alterations or repairs to the machinery?—The workpeople do none, only the the foreman.

1737. Are you quite sure of that?—Yes, I am quite sure, and they had no right to do so.

1738. If we have been informed that they do it, do you say that the information is incorrect?—I say that they should not, except, perhaps, in the case of packing a plunger when the foreman might stand by, and a man might turn the screw.

1739. That would be the only thing which you think should be done by the men?—Yes.

1740. *Sir F. Abel.* Packing a plunger is a frequent operation, is it not?—Yes.

1741. Suppose the foreman were away taking the density, is it not likely that the men would do it?—I do not believe they would do it.

1742. *Colonel Lloyd.* Supposing the foreman told them to do it?—If that was so, I think, a man might, but I doubt a foreman telling him, if he did it is unbeknown to me, and I have never heard of it. I should say it would be improper for a workman to do that.

1743. *Colonel Majendie.* With regard to the removal of powder, would a machine be cleared for packing a plunger?—No, not for that; you only want to turn a screw, not take it out.

1744. In the case of alterations, such as replacing plungers and putting in new pins, and carrying out repairs of that sort, would you remove the powder either from the house or part of the house where the work was carried on?—Yes.

1745. With regard to searching the men to see that they have no pockets in their clothing, and no iron fastenings, do you think that the regulations would be satisfied with the foreman looking at the men, say, once a week?—I think it should be every day, there are instructions for it.

1746. Written instructions?—No, verbal, they are asked every day if they have done it, I have asked them myself.

1747. Then if a foreman went for a week, or a fortnight, he would not be observing what you understand to be the regulations upon the point?—That is so.

1748. We understand that there is some sort of recess in the floor, near the doors, for dirty mats, but that near the shoe room was a clean mat?—That would be a dirty mat too.

1749. Do you consider the shoe room is clean or dirty?—Dirty.

1750. Is it the case that there are certain boards the men walk upon in order to keep their shoes clean?—Yes, in every shoe room.

1751. Are those boards fixed or removeable?—All removeable.

1752. Where would they generally be?—Here [the witness explained where the boards would be, and also pointed out the mats where the Officers of the factory would go into the cam house].

1753. With regard to the implements that were habitually present in the house, can you tell us exactly what they were; we have heard of a steel spanner more than once?—That is almost a screw-driver, it is hardly a spanner. [The witness explained by means of a diagram, *see* Appendix III., the shape of the implement.]

1754. Is it the only steel tool used in connection with the machines?—There is another spanner, a metal one, for altering the cross-heads.

1755. The alteration of the cross-heads would have to be effected by the workpeople, I presume?—No, by the foreman.

1756. Would it be contrary to what you under-

stand by the rules if they did?—Yes; no one should interfere with the cross-heads except the foreman.

1757. Then those two tools were intended to be used by the foreman without calling in the mechanic?—Yes.

1758. Do you think that is sufficiently clear from these cam-house rules; do you consider, under Rule 6, that the foreman is the only "duly authorised" person to carry out those repairs?—Yes.

1759. With regard to the searching, and the observance of the other regulations, it has been stated more than once that there is no written report, no signed certificate, that a foreman has done this or that?—No.

1760. Is it not in your judgment desirable that some more strict measures should be taken to ensure that that is done? In the first place, to whom does the foreman report?—To the other foreman who visits the house.

1761. He says "it is all right," and that ends it?—Yes.

1762. Do you think that is sufficient? Should not the foreman make a written report, or sign a certificate, or in some way commit himself to what he says?—I do not see any objection to that.

1763. Do not you think it would be an advantage to do that?—No.

1764. If you became acquainted with the fact that the men were only searched once a week or fortnight, would your opinion upon the desirability or otherwise of a written report be modified?—You would only get the foreman's bare word for it then as you do now; you would get it in black and white, but it would only be his bare word. I would just as soon take a foreman's word as his written statement.

1765. Would not that apply to all reports?—There is no objection to a written report if the Superintendent says it is necessary.

1766. *Sir F. Abel.* Do not you think a man is more likely to think twice about a thing if he has to write it down?—I think not; a man's word is his bond in any case.

1767. *Colonel Majendie.* If a man says "all right" on Tuesday and Wednesday, when he has inspected those men only on Monday, he is making a false statement, is he not?—He is doing the same if he puts it in writing.

1768. Then do you think that something more than a written or verbal report is necessary to secure that the thing would be properly carried out?—Yes.

1769. What would you suggest?—That the foreman should have a form to fill up that he had done such and such a thing.

1770. That is what I am suggesting, do you think that would secure it?—He would be bound to say that he had done it.

1771. Would not that be an advantage?—Yes, as far as that goes.

1772. In your collection of curiosities at Waltham are there not some prisms that have been found with foreign substances in them?—Yes, pieces of wood and part of a pin.

1773. Any pieces of flint or iron?—No.

1774. At present they pour the powder into the hopper so that whatever there might be in the powder would pass, of course, into the hopper, and then ultimately into the machine?—Yes, of a certain size, but not a large thing.

1775. Would it not be possible to have over the top of the hopper a sort of searcher so as to prevent anything of a dangerous character going into the machine?—It would have to be so large that I do not think it would be of much use; the mesh would have to be very large to allow the powder to go through because there is no shaking arrangement on this machine as there is with a granulating machine.

1776. Then you think it would not detect every foreign body that might be dangerous?—No.

1777 Have you seen men sitting down in the house?—I do not remember seeing any man doing that.

1778. *Sir F. Abel.* Was there any provision there for sitting down?—No.

1779. *Colonel Majendie.* Are you sure there was no barrel?—Yes, if there was it was one they had turned upside down.

1780. Then you think that any evidence we may have that there was that sort of thing is incorrect?—I do, I never saw it.

1781. *Sir F. Abel.* Is there any reason why there should be empty barrels there?—None whatever.

1782. *Colonel Majendie.* Have you seen the men generally standing right up to the machine?—Yes.

1783. How long would it take for the hopper to empty itself?—It is not allowed to empty itself, the man would put powder in it about every five minutes to keep the hopper full. A man's orders are, that he should stand at the machine in case the front man wanted him to pull the clutch out, his duty is to stand by in case he is wanted. I never saw a man sitting down.

1784. Have you ever heard anything at any time about some sparks being struck by one of these spanners?—Wraighte said he was unscrewing one of the plungers when the spanner struck some sparks, but I should like to point out that the house was cleared of everything when that was supposed to have been done. Colonel Barker went down to the house and saw Wraighte, and investigated the thing, and he said he did not believe it, nor do I. Wraighte was taken away from the cam house in consequence of that.

1785. Has he ever made any other complaints about danger or risk?—No.

1786. *Sir F. Abel.* How could a man be engaged in such work; because you say under no circumstances should he do those things?—But all the work was stopped.

1787. Then the foreman would be instructing him to do it?—Yes. With reference to what I said the other day about matches, I should like to say that it was only yesterday that I found, in February, 1889, there was a man found with a box of matches in his great-coat pocket, hung up in the shoe-room of one of the houses. When the foreman found those matches he immediately brought the man down, and he was discharged at once. It was a very wet morning, and the man put on his private coat to go to the house. Since then every man has had a great coat given him, so that now they do not have to take their private coats to the houses.

1788. Have you known any cases of single matches being found?—Yes, I know in 1864 matches were found on the magazine floor.

1789. *Sir F. Abel.* What steps are taken by you to make sure that the men are acquainted with the rules?—There is a copy of the general rules at each entrance to the factory; each man had a copy at one time, but those copies have now been taken away.

1790. Are the rules read to them?—No; they used to be, and everything was explained to them, and the foreman signed a book that he had read them over.

1791. *Colonel Majendie.* Why was that rule altered?—They were done away with when the Ordnance Factory rules came in force.

1792. Would it not be desirable for the men to have something in their own possession?—Yes, I think so.

1793. Are you responsible for the general rules?—No, I am not responsible for any rules.

1794. Have you studied these rules at all carefully and methodically?—No, I was not asked about them when they were drawn up.

1795. In those general rules, I believe, there is no rule forbidding repairs to be carried out until the house has been cleared of powder?—No.

1796. And if you took the press-house rules, which would supplement these, I do not think you will find any rule in them as to repairs?—No.

1797. So far as the written rules go, there is no order that the press-house man should not carry out repairs?—That is understood, but there is no formal regulation.

1798. *Sir F. Abel.* Is not the washing out of the cam machines a very important operation?—Yes.

1799. There is no reference to that in the rules?—No.

1800. *Colonel Majendie.* In regard to the articles liable to spontaneous ignition, such as sponge cloths, there is no rule, I believe, upon that subject?—No.

1801. What do you understand to be the practice with regard to sponge cloths?—No oily sponge cloth is to be left in any building, they are to be taken out each night.

1802. Then if they were taken out only every Saturday morning, that would not be complying with the regulations?—No.

1803. There is no regulation that they would be disobeying?—No, there is a receptacle outside every house

1804. Do you suppose, as a matter of fact, that they are removed from this house daily?—I have not the slightest doubt.

1805. Do you think that any evidence to the contrary is incorrect?—Yes.

1806. Even if it were the evidence of a foreman?—Yes.

1807. *Sir F. Abel.* How many are supplied to them?—As many as are required, there is no stint.

1808. *Colonel Majendie.* With regard to the night inspection of these houses, do you know what time the head millman generally makes his round?—He can go which way he likes, to the upper works first or to the lower works first.

1809. Did he often go to the cam-house at 2 o'clock in the morning?—I cannot say.

1810. What is your belief, do you think he visited that house in the small hours of the morning, or only early in the evening?—I believe he would visit it at about 10 or 11 o'clock in the night when he went down to the lower works.

1811. And not again?—He would go only once in any case, the house was immediately under the foreman.

1812. *Colonel Lloyd.* What is exactly the object of the footboards?—A man might go out into the shoe-room to get a drink, and in order to get there he would step on to these clean boards so as not to have to take his boots off.

1813. Would the footboards ever be brought into the house?—Never.

1814. There would never be any necessity for that?—Certainly not.

1815. *The Chairman.* A man might step off one of those boards on to the dirty floor?—Yes, he could do that if he liked.

1816. *Colonel Lloyd.* Have you ever known a man to do that?—No.

1817. Do you think they would be so careful as never to do that?—Yes.

1818. Was Wraighte removed from the cam-house as a punishment?—No; he is a man with a peculiar disposition, an off-hand sort of man, and treats me with contempt.

1819. Is he a grumbler?—Yes, and he has always been a grumbler.

1820. You place no reliance upon what he said with reference to the sparks?—I believe it was a falsehood.

1821. Why was he removed?—Colonel Barker took him away because he was not satisfied with him.

1822. Did that entail a loss of wages?—No.

1823. Was not the receptacle for the sponge cloths outside the house a dirty receptacle?—Yes.

1824. Would those sponge cloths be brought in again next day for use?—No, but if they wanted to wipe up a dirty place they might do such a thing.

1825. Then there is a possibility of grit being brought into the house?—No, the tank is about 2 feet deep, but open at the top.

1826. If there were an accumulation of dust it would be at the bottom?—I do not think dust would be there any more than on the clean platform.

1827. As a matter of fact, sponge cloths are put into a dirty receptacle, and might be brought out again next day?—I do not say they are.

1828. But they must be either in the house or out of it?—They are not left in the house. A cam machine is working night and day, and the cloths are not taken out every hour; they stop there till they are dirty, and then they are thrown into the tank outside.

1829. Is it a fact that sponge cloths which are put into a dirty receptacle outside the house are ever brought into the house again for use?—Not to my knowledge.

1830. *The Chairman.* Is Mumford a discontented man?—Since the accident it appears so, though no complaint has ever been made of him. What he said at the inquest was talked over in a pot-house, and it is entirely false. If he ever did what he said he did he ought to have been discharged.

1831. *Colonel Lloyd.* We have had evidence that the men sometimes take their meals in the shoe room, do you see any objection to that?—I do not see any objection to it, because they have only half an hour for their meals, and if they had to go down to the dining room, they would not have sufficient time for meals.

1832. But with regard to the cam-house, is the dining room far away?—About three minutes' walk.

1833. Do you think it would be an improvement in the regulations if, where a dining room was within a reasonable distance, men were compelled to go to a dining room for their meals?—Yes.

1834. The machines are stopped during meal times?—Yes, and the house closed.

1835. Is the house locked up?—Yes, by the foreman.

1836. *Sir F. Abel.* Do they sweep it down before they go away?—It is cleared.

1837. *Colonel Lloyd.* But not washed out?—No.

1838. How often is a house of that sort, with a leather floor, washed out?—When we do the repairs, but it would be swept constantly. The more you wet a leather floor the worse it is, and the more powder sticks to it.

1839. But not if it is dry?—You could not wet a floor and get it dry in half an hour or an hour.

1840. Do you know of any material better than leather which would bear cleaning without serious injury, would kamptulicon do?—I do not think anything could beat leather as to wear.

1841. But as to the possibility of getting ingrained with powder?—Kamptulicon would not last so long.

1842. Do you think it would be a precaution if all the leather floors were washed a little more often than they are?—I think not.

1843. Do you think it would act in a contrary direction?—Yes; as long as the place gets properly swept you get no powder on it, but if you wash the floor the powder would stick on.

1844. If the leather floors were washed on Saturday night would they not be dry enough by Monday?—They would be dry but they would all be like wet saltpetre on the top; I think you should not wash out a house as frequently as that when you can keep the floors clean by constantly sweeping. Our floors are very clean, and they compare well with those of any other factory into which I have been.

(The Witness withdrew.)

1845. *The Chairman.* Have you anything you wish to say with reference to your previous evidence?—Yes, I said that the spanners were only used by the mechanics in the house, but I now find the foremen use the spanners for packing up the plungers.

1846. And, so far as you know, no one but the foreman and the mechanic use those implements?—That is so, the order is that no repair is to be done by the workman.

1847. If a man did anything of that sort he would be doing something which is contrary to the regulations?—Yes, he should have spoken to his foreman.

1848. *Colonel Majendie.* We understand that the men coming into the factory on the barges are subject to the same sort of inspection by the police as the men coming to work in the factory?—Yes, they search the barges.

1849. They ask the men, but they do not go further than that?—I do not know that they do.

1850. Do you think it is altogether satisfactory that contractor's men should be able to come in with less supervision than the man who, so to speak, carries his life in his hand?—No, I do not, but the contractors are not under me in any way.

1851. But apart from any question of such responsibility, do not you think it desirable that some regulations ought to be made to operate very stringently against the bargemen?—Yes.

1852. I suppose I am right in saying that there is no punishment attached to a bargeman, he may be reported, but he cannot be dismissed, by you at any rate, whereas one of your own men would be dismissed?—That is so.

1853. The bargemen do disembark when they get into the factory, do they not?—A man might come ashore to get a drink of water, or to eat his dinner.

1854. *Sir F. Abel.* Are the men employed in the Engineer Works Department subject to the general rules?—They are searched by the police.

1855. But only a percentage?—Yes.

1856. Have they to work in the danger buildings?—Yes, but the building is washed down and cleared before they come in, and it is always looked over carefully afterwards.

1857. *Colonel Majendie.* Are you under the impression that the men are searched by their foreman daily?—Yes.

1858. You would not consider searching men weekly or fortnightly satisfactory, would you?—No, I think they should be searched every day.

1859. And that you understand is what is required to be done?—Yes.

1860. Can you point to any written rule or regulation requiring that?—No, I do not think it is either written or printed.

1861. Do not you think it would tend to ensure a more rigorous carrying out of any rule if a foreman had in some way to certify daily that he had carried out his duty?—I do not think the fact of sending in a written report ensures a man having done his work any more than a verbal report does.

1862. Do you think a verbal report is as good as a written one?—Yes.

1863. But is there not a greater formality in putting your name to a written report?—I think the man who signs a false report would make a false statement.

1864. *Sir F. Abel.* But if anything comes to your knowledge afterwards, have you not more hold over a man who has signed a written report, because in the case of a mere verbal report he might say you had mistaken him?—Yes.

1865. *Colonel Majendie.* To whom are those verbal reports made?—To the master worker, or to my assistant, or to myself. We go round very frequently. We ask the foreman "is it all right?" and he says "yes," or "no," as the case may be.

1866. Are you quite sure that the foreman understands that in saying "all right," searching the men under his control is included in his "all right"?—I think so.

1867. If a foreman told us he searched the workmen only weekly or fortnightly, he would be doing one of two things, either he is deceiving the persons to whom he reports, or he is misunderstanding the regulations?—Yes, a foreman ought to search his men every day in the danger buildings; I can easily have a report sent in daily.

1868. Would it not be well to have it formulated, and have a definite rule upon that point?—It could be done on the printed rules in the house.

1869. Has the question of a modification of these rules occupied your attention?—The question is in abeyance, while this Committee is sitting.

1870. With regard to the publication of the rules we have not been able to ascertain quite clearly how the men know what the rules are?—When a man is taken on, the master-worker has all the general rules explained to him, and the rules of the special house are explained to him by the foreman.

1871. We understand that the general rules are only posted up at the gate, and here and there about the works?—Yes.

1872. It appears to have been sometimes the case to give the men a book of rules with those and others in them?—Yes.

1873. That has been discontinued?—Yes, since the time the Ordnance Factory rules were started; here is a copy of the book which is now given to the men [handing in the same, extracts from which are printed in Appendix V.].

1874. But these rules do not touch the question of safety?—No.

1875. Would it not in your opinion be an advantage to adopt a system by which every man would be required to have a copy of the rules in his possession, would not that tend to procure a more general knowledge of the rules?—Yes, I think it would.

1876. Do you approve of the practice of meals being taken in the shoe room occasionally?—I do not see any harm in it, but they have a more comfortable place to get their meals in if they wish.

1877. Then you do not think it tends to irregularities to bring food into a place which is a *quasi* clean building?—It is a dirty floor.

1878. But the footboards make it a clean building because a man can stand on some parts without changing his boots?—Yes.

1879. Would it not be desirable that the men should be altogether excluded from the shoe room when taking their meals?—It might be a precaution.

1880. Would they not bring knives and earthenware vessels, which are liable to give off sparks?—Yes, but in their baskets.

1881. Is the shoe room lined?—That particular one was built of wood, except one wall, which was of brick; it has a slate roof.

1882. Was there anything dangerous in the room which could possibly have fallen?—I think not.

1883. We understand that a granulating house is unlined, and therefore objectionable upon that ground; was there anything of the same sort about this house to make it objectionable?—No.

1884. You think if it had a clean floor it would be as safe as a powder house?—Yes.

1885. Who took the evidence of the men which you have handed in (*see* Appendix VII.)?—Captain Nathan.

1886. Were the men up in the office?—Yes.

1887. Did they give the evidence willingly?—Yes.

1888. One of them, Steele, says this: "Carr told Nurse Jones, and I heard it, that he saw sparks under the hood of the magazine," what does that mean?—I do not know what he means, unless he refers to the expense magazine, which lies about 50 yards to

the north of this house. I have spoken to Carr, but he did not tell me anything about that; he is still in hospital.

1889. Clarkhall: "Do you consider the machines dangerous, and if so, in what way? Yes, when the charger would not come over owing to the powder getting under"?—The dust sometimes gets in and clogs the charger.

1890. Has that ever been brought to your attention as a matter of risk?—No, it requires the constant attention on the part of the men working the machines.

1891. "Larman said it was Clayden's machine that went first"?—Yes, and Clayden said so too.

1892. Wraighte said, "Emery ought not to be used in cleaning the machines," Is that used?—Yes, I think it was, but I have stopped it now.

1893. Ephgrave suggests that holes should be made in the bottom of the machine for squirting water in, has that been considered at all?—We have not touched that at all yet.

1894. Several of the men seem to have been anxious to work in the cam houses, and one man said it was because they get better pay; do they get better pay?—It depends upon the job they are on.

1895. Was it a highly paid house?—No, they got 28*s.* or 29*s.* a-week for 12 hours a-day.

1896. Eve: "The iron roller over the counter-weight made each machine dangerous," what does that mean?—The cross head carrying the upper plungers is pulled in one direction by a heavy weight that goes over pulleys.

1897. Is there the risk indicated here that they might fall on the machine if it broke away?—If its axis broke it might be a danger.

1898. Will the machines receive your attention before they are used again?—Yes.

1899. "Pipes at the bottom of machine to carry water away, and parts to be painted," will those points receive your attention?—Yes.

1900. *Sir F. Abel.* In your report you say that the only possible suggestion that has occurred to you in reference to the explosion is that a match might have been dropped in the powder barrel, have you any reason for making that suggestion?—No, I cannot imagine anything else; the match might have been in the man's private clothing, underneath his lasting clothing.

1901. *Colonel Majendie.* If a match could get into a barrel it might get into the machine too?—Yes.

1902. Have you any reason for thinking the explosion originated at the barrel rather than at the machine; let us suppose a match from some source, is it likely it would declare itself at the barrel or at the machine?—If it originated at the barrel it would communicate with the machine and *vice versâ*.

1903. Your report tends to show that it would occur more probably at the barrel than at the machine?—I think a match is more likely to have tumbled out of a man's clothing on to the floor.

1904. You do not think the match got into the powder barrel?—No, I think perhaps it tumbled out of the pocket while stooping.

1905. *Colonel Lloyd.* Have any experiments been tried with a view to showing the inflammability or explosibility of a leather-covered floor that has been well worked with powder for months; I mean, has a match been thrown down upon such floors?—I do not know.

1906. Would there be a tendency for fire to spread over a leather floor under these circumstances?—Yes, I think it is very likely.

1907. Would you advocate more water being used in this house for cleaning the floors?—It would do them no harm to wash them out occasionally.

1908. We gathered from one witness that if that were done to any extent there would be an efflorescence of saltpetre on the floor after washing over the leather, and that the chines of the barrels would be more or less muddy with powder mud, does that objection occur to you?—There would be something in that, certainly.

1909. Are you yourself satisfied with the present arrangements for sweeping the floors?—I think they are kept very clean.

1910. All the evidence tends to show that a great deal of the trouble connected with these machines arises from the pins becoming bent. Do you see any objection from a danger point of view to prisms being pressed solid, and then bored out with a suitable drill?—I think there would be more danger in boring them out than under the present system. There would be more heat in boring them, because they are very hard.

1911. Do you think that method of manufacture would be so dangerous as to make it impossible?—Yes, I should prefer the present method.

1912. With all its disadvantages?—It has been considered perfectly safe until this accident.

(*The Witness withdrew.*)

FRIDAY 16TH FEBRUARY, 1894.

Present.

Lord SANDHURST, *Chairman.*

Members.

Sir F. A. ABEL, Bart., F.R.S.
Major-General F. T. LLOYD, C.B., R.A.

Mr. R. H. BRADE, *Secretary.*

Colonel A. FORD, *examined.*

1913. *The Chairman.* You are one of the Inspectors of Explosives under the Home Department, I believe?—Yes.

1914. Under what Act were you appointed?—Under the Explosives Act of 1875; I also served for some time previously under the Gunpowder Act of 1861.

1915. How long have you occupied your present position?—For over 20 years; that is, from 1873.

1916. Have you during that period had much experience in regard to the licencing and inspection of factories for explosives of all sorts?—Yes, I have had very great experience in those matters.

1917. How many factories are there at present which are subject to the inspection of Her Majesty's Inspectors of Explosives?—127 in all; 85 of which have been licensed since the passing of the Act, and 42 were taken over as legally existing at that time; these latter had what is called a "continuing certificate."

1918. What is meant by a "continuing certificate" factory as distinguished from one under a licence?—If a factory was legally existing at the time of the passing of the Act of 1875, the occupier was entitled to a "continuing certificate" if such was claimed within three months of the date of the Act coming into force, viz., before the 31st March, 1876.

1919. In the case of a factory under licence does every application for a licence come before the department of Her Majesty's Inspectors of Explosives?—Yes.

1920. What is the course that is taken in regard to such applications?—The occupier of the proposed factory submits what he considers to be a suitable plan of the site, showing the positions of the different buildings, and states the amount of explosive and the number of workpeople to be allowed in each, and the distances they are to be apart from each other. If we find all those details satisfactory, then we grant a draft licence based on them, but if they are not satisfactory, we point out in what particulars they fail.

1921. Are all those details inclosed in the draft which you receive from the owner of the factory?—What he sends up is often only a very rough draft, and we put it into shape.

1922. Do you, for that purpose, send him down a set of questions to answer?—A great deal of correspondence usually takes place; but if it is a large factory we generally ask the owner or occupier to come up and see us at the Home Office, and then we thresh out details in an hour or two which would probably take us weeks to do by correspondence

1923. When a licence is granted, can any alteration be made in it without reference to the Secretary of State?—No, none at all.

1924. Suppose some alteration is required, how do you set about effecting that?—The occupier has to apply for an amending licence.

1925. Then it appears that you have practically to go through the same form you have gone through before, and see that everything you require is complied with, the same as when you are dealing with an original licence?—Yes, unless the alteration is of a minor character, in which case the amending licence can be granted without reference to the local authority; and in the case of a factory under "continuing certificate" the occupier can get an amending licence without having to go to the local authority, whatever the nature of the alteration.

1926. *Sir F. Abel.* I understand that an amending licence would apply, not merely to some modifications in the arrangements in the factory, but also to modifications with regard to explosives manufactured?—Yes, any alteration of any kind; any deviation from the original licence would require an amending licence.

1927. Then, at the very outset, the amending licence deals with the most important part of the whole question, namely, the nature of the explosive; and no explosive can be manufactured until the place is considered so far satisfactory that it can be licensed?—That is so. The explosive has to be considered first of all; but, beside that, there are the other details included in the licence.

1928. *The Chairman.* In granting licences, is attention paid to the protection of buildings and works outside the factory?—Danger buildings are all required to be at specified distances from buildings and works outside the factory.

1929. And are the danger buildings required to a certain distance from one another?—Yes; the distances in both cases depend upon the amount of explosive that may be allowed in each separate building.

1930. When you say "explosives in separate buildings," do you include in that what might be in boats or wagons within a certain distance of the danger building?—Yes.

1931. On what principle are these distances, or safety zones, assigned?—They depend entirely upon the amount of explosive in the building, except in cases where the quantities are small, and then the nature of the explosive is also taken into consideration. Where the quantities are as much as 5,000 lb., we require the same distances for all explosives, except fireworks, when the distances are much reduced.

1932. *Sir F. Abel.* Quantities of 5,000 lb. would have reference entirely to magazines, would they not?—It is quite possible that that amount might be in a working building, though I cannot at present call to mind a building where it is so; it might, for example, be in a building required for blending.

1933. *The Chairman.* Can you supply the Committee with any table showing the distances which would be required for the various quantities?—Yes, here is a table showing distances from protected works for magazines and other danger buildings [handing in the same, *vide* Appendix XIV.] This

table has been compiled from the results obtained from explosions that have actually taken place.

1934. Is the distance which is assigned to every factory, or to different buildings in the factory, included as a condition of the licence?—Yes, it is inserted in the form of a schedule.

1935. Is the manufacturer free to alter any of those distances without the permission of the Secretary of State?—No, if a distance is to be altered he must come to us for an amending licence, and if the distance is reduced, then we reduce the amount of explosive allowed in the building.

1936. *Sir F. Abel.* Has a manufacturer to come to you when dwelling houses are erected within the distances specified in your schedule?—Yes.

1937. *The Chairman.* Therefore a person does not build his own house at his own risk?—No, in that case the manufacturer cannot go on using the particular building under the old licence.

1938. Has the drafting of licences in a great number of cases come under your immediate control?—Yes.

1939. When a licence has been drafted, is it required to run the gauntlet of any local criticism?—It is sent in the form of a draft licence to the applicant who, after advertising in the local papers for at least a month, takes it before the local authority. The local authorities do not go into the details at all; they either assent or dissent, and their objections, if they have any, are generally from a residential, or some similar, point of view. If the local authority assents, then on the assent reaching us, we tell the occupier to build the factory in accordance with the draft licence, and when the building is sufficiently completed to enable manufacture to be commenced, the draft licence is confirmed. If the local authority dissents, or imposes conditions, the applicant is asked whether he submits or agrees to the conditions, or whether he wishes to appeal. If he submits there is an end to the matter; but if he does not submit or agree, he has a right of appeal to the Secretary of State, with whom there rests the final decision, and who has power to grant the licence over the head of the local authority. We have had some eight or ten cases of such appeals; some have been granted, and some refused.

1940. Can you show us one or two typical licences to illustrate their scope and nature, and also the detail into which they run?—Yes; here is our copy of the licence which was granted to the E. C. Powder Company [exhibiting the same to the Committee. A copy of a magazine and one of a factory licence will be found in Appendices XII. and XIII.]

1941. Can you also show us an amending licence?—Yes, here are some twelve amending licences which have been successively granted to the same company [exhibiting the same to the Committee]. Very often the whole of the buildings are in some way altered, because as he goes on the manufacturer gains experience, and he finds that he cannot work on the original lines.

1942. Then it follows from what you have said, that the licence itself contains a number of regulations which have to be observed?—Yes, it is practically all regulations.

1943. What is the penalty for a breach of the terms of a licence?—A fine not exceeding 50*l.* *plus* the forfeiture of the explosive in the building in which the breach took place

1944. If a manufacturer subsequently conforms to the regular requirements, does he get his licence at once?—His licence is not taken away if he commits a breach.

1945. Are there any rules outside the terms of the licence?—There are the general rules for gunpowder factories contained in Section 10 of the Act, and for factories for explosives other than gunpowder there are the rules in the Order in Council, No. 2.

1946. With regard to the general rules are they posted up in the factories?—They are required to be posted up, as also are the special rules, in the danger buildings.

1947. Are the general rules posted up at the gate of the factory?—I cannot recall any instance where the rules are at the gate; they are in or about the danger buildings, sometimes outside the houses in glass frames, but mostly inside.

1948. Can you refer the Committee to the general rules applicable to gunpowder factories, and also to those applicable to factories for explosives other than gunpowder?—Yes, the first you will find in Section 10 of the Explosives Act of 1875, at page 153 of the seventh edition of the guide book, and the second you will find in the Order in Council, at page 249 of the same book.

1949. How are the special rules arrived at?—Under Section 11 of the Act the occupier of a factory is entitled to make special rules for the regulation of the persons managing, or employed in or about, his factory with a view to securing the observance of the Act, and for the safety and discipline of such persons and for the safety of the public. If after being required to do so an occupier does not within three months submit some such special rules to the Secretary of State, then the Secretary of State has power to make the special rules, but no special rules can be operative until they are sanctioned by the Secretary of State.

1950. Can you show the Committee a copy of such special rules as have been approved in the case of a gunpowder factory, and in the case of a factory for explosives other than gunpowder?—Yes, here is a copy of the special rules compiled by Messrs. Curtis's & Harvey, and here is also a copy of the special rules used by Nobel's Explosives Company [exhibiting the same to the Committee].

1951. Do these special rules vary in different factories, and under different circumstances?—Yes.

1952. Can they be varied without the sanction of the Secretary of State?—No, all alterations have to be submitted for sanction.

1953. Are there any rules of the nature of extra special rules applicable in factories?—Yes, in certain cases. For instance, it was found that a copper stud used in some mills was liable to cause an explosion, and therefore the manufacturers submitted an extra special rule forbidding the use of it. The principle we adopt in going through these rules for approval is to make as few alterations as possible. If, therefore, a manufacturer submits a special rule for a particular building, we accept it; and if he submits an extra special rule, we take it as such. It is immaterial to us whether he calls it one or the other, as the penalty is the same.

1954. What are the penalties for breaches of the general and special rules?—Not exceeding 10*l.* and forfeiture for the general, and not exceeding 40*s.* in the case of the special rules.

1955. Is a manufacturer at liberty to make any other rules than those which you have mentioned?—No.

1956. I presume, if he did make any such rules, he could not recover any penalties against his workmen for a breach of the same under the statute?—No, not under the Explosives Act.

1957. In the case of factories under "continuing certificates," do the general and special rules apply?—Yes.

1958. Does the certificate itself contain regulations similar to those in a licence?—Yes, *mutatis mutandis*; but if the occupier wishes to add a new building, or to make an alteration in an existing building, then we assign the same safety zone as in a licensed factory.

1959. Is it the practice in the Home Office to include as one of the terms of the licence that inflammable clothing is to be worn, but no pockets?—Yes.

1960. Do Her Majesty's Inspectors of Explosives pay particular attention to the observance of that

regulation; do they attach considerable importance to it?—Yes, I examine the men very particularly.

1961. Just at haphazard?—Yes. Sometimes I take three or four men in succession in one room, but I do not necessarily examine all who are in the room. It all depends upon the factory I am inspecting.

1962. Do you consider that a system of occasional search of the workpeople by the foremen of the different houses is a satisfactory one?—No; the search should be made every day, and at the time the men come into the factory.

1963. Then you would think 10 or 15 per cent. quite inadequate?—I should not consider that satisfactory.

1964. What sort of system do you think should be enforced to ensure every workperson being subjected to an efficient daily examination?—A man should be searched when he comes into the factory, and then after he has changed his clothes, the clothes left behind should occasionally be searched, because very often things are found which were not detected in the examination at the gate. The second search would be a very good thing, because if the men know that an examination of that kind may be carried out they will be almost certain to search themselves beforehand so as not to bring anything into the factory.

1965. Do you think it is desirable that the responsible person reporting having searched the workpeople should make such a report in writing?—Yes.

1966. Is that practice adopted in the better regulated factories?—Yes.

1967. In the case of the women, do Her Majesty's Inspectors insist upon some woman searcher being made responsible?—Yes, always a forewoman; we speak to the forewomen and ask them whether the inspection has been rigidly carried out. If I suspect that a workwoman is wearing her own dress under her inflammable clothing, I ask her to turn up her inflammable clothing to see that she has no pockets in her own clothing.

1968. Then you do actually look at the clothing of the workpeople when you visit the factories?—Yes.

1969. Are those visits made without notice?—Yes, any sort of notice would spoil the whole thing, and if we happen to find out that it is known that we are in a district we sometimes leave it, and go to another.

1970. With reference to the general rules, relating to gunpowder factories, can you point out to the Committee any rule relating to oiled cotton, rags, and other articles liable to spontaneous ignition?—Yes, Subsection 4 of Section 10 of the Act says, "Charcoal, whether ground or otherwise, and oiled cotton, oiled rags, and oiled waste, and any articles whatever liable to spontaneous ignition shall not be taken into any danger building, except for the purpose of immediate supply and work or immediate use in such building, and upon the cessation of such work or use shall be forthwith removed." That is a point to which we pay particular attention, and I do not think that, with one exception, I have found any cotton waste in a building for the last five years. Not long ago I found a piece which had been momentarily left behind.

1971. Do you consider that a rule to which considerable importance is attached?—Yes, undoubtedly.

1972. Can you point to any rule relating to repairs to danger buildings?—Yes, Subsection 5 of Section 10 of the Act says, "Before repairs are done to, or, in any room in or other part of a danger building, that part shall, so far as practicable, be cleared by the removal of all gunpowder and wholly or partly mixed ingredients thereof, and the thorough washing out of such room or part."

1973. Does that rule apply to repairs to machines?—Yes.

1974. That would stop the working of all machines while repairs were going on?—Yes.

1975. In your judgment, is that a rule of considerable importance?—Yes, of the greatest importance, because numerous accidents have resulted from repairing or altering machines while explosives were in the rooms; here is a list of such accidents [handing in the same, *vide* Appendix VIII.].

1976. Do the rules require full statements to be posted up of the quantities of explosive allowed, and the number of persons, and the regulations applicable to the building?—Yes, Subsection 6 of Section 10 of the Act says, "There shall be constantly kept affixed in every danger building, either outside or inside, in such manner as to be easily read, a statement of the quantities of gunpowder or ingredients allowed to be in the building, and a copy of these rules, and of any other part of this Act required by the Secretary of State to be affixed, and of such part of the licence and special rules made under this Act as apply to the buildings, and with the addition in a factory of the name of the building, or words indicating the purpose for which it is used." The number of work persons must also be posted up.

1977. Does any obligation rest upon the manufacturer under any section of the Act of using due diligence to enforce the observance of the Act?—Yes, Section 23 of the Act says, "The occupier of every factory, magazine, store, and registered premises for gunpowder, and every person employed in or about the same, shall take all due precaution for the prevention of accidents by fire or explosion in the same, and for preventing unauthorized persons having access to the factory, magazine, or store, or to the gunpowder therein, or in the registered premises, and shall abstain from any act whatever which tends to cause fire or explosion, as is not reasonably necessary for the purpose of the work in such factory, magazine, store, or premises. Any breach (by any act or default) of this section in any factory, magazine, or store, or registered premises, shall be deemed to be a breach of the general rules applying thereto," and is liable to the same penalty of 10*l*. Section 87 of the Act says, "Where any offence under this Act for which the occupier of any factory, magazine, store, or registered premises is liable to a penalty, or forfeiture, has, in fact, been committed by some other person, such other person shall be liable to a penalty not exceeding 20*l*. Where such occupier is charged with an offence so committed by some other person, the occupier shall be exempt from any penalty and forfeiture upon proving that he had supplied proper means and issued proper orders for the observance, and used due diligence to enforce the observance of this Act, and that the offence in question was actually committed by some other person without his connivance, and if the actual offender be alive, that he has taken all practicable means in his power to prosecute such offender to conviction." These two sections deal with the matter very fully.

1978. Is it consistent with the general rules that steel tools or implements should be used in the repairs to any danger building?—No, Subsection 7 of Section 10 of the Act says, "All tools or implements used in any repairs to or in a danger building shall be made only of wood or copper or brass, or some soft metal or material, or shall be covered with some safe and suitable material."

1979. *Sir F. Abel.* The whole of a steel spanner could not be covered, could it?—No, not quite the whole of it.

1980. *The Chairman.* In regard to the keeping of the building free from grit, is it important that the magazine boots should never be placed where they can come into contact with grit?—Yes.

1981. In your judgment is there a liability of their coming into contact with grit where they are worn along an unprotected external platform?—Yes.

1982. I presume with regard to the exclusion of grit, you consider that it is very important that the "clean" boundary should be carefully defined?—Yes, that is absolutely necessary, otherwise the boots must take up grit.

1983. Do you consider that mats to wipe the feet

upon should be allowed within the "clean" boundary?—No, that would be a most objectionable practice; mats are not required at all if there is a proper clean floor boundary. If mats are placed outside a building to wipe the feet on, they are very liable to throw grit into the building.

1984. Is it the practice in the private trade to allow meals to be taken in the danger buildings, or in any part of the same?—That is absolutely forbidden.

1985. *Sir F. Abel.* Can they take their meals in the shifting rooms?—Yes.

1986. Are they not in close proximity to the danger buildings?—No, they are invariably the same distance from the danger buildings as those buildings are from one another.

1987. *The Chairman.* Would you object to their having meals in the danger buildings, if you found such a practice in operation?—Yes, because there would be the liability of their bringing cups and saucers and earthenware basins, and iron or steel knives into the buildings. We are very particular upon that point, and if we find there is the slightest approach to such a practice we at once put a stop to it.

1988. With regard to smoking, is that absolutely prohibited in the private factories, or do the rules allow of certain places being assigned where smoking may be carried on?—Yes, that is done under Subsection 9 of Section 10 of the Act, "No person shall smoke in any part of the factory or magazine, except in such part (if any) as may be allowed by the special rules." In some factories smoking is entirely prohibited, in others it is allowed, but only in the watch-houses and dining rooms. Of course if there is any dwelling house within the factory area smoking is allowed there.

1989. Does not that entail searching the men who come from such places and go into danger buildings?—Where matches are allowed to be in a factory, we always provide that they shall only be safety matches, and that they shall be kept in one particular place from which they must not be removed, so that if a man wants a light he has to go to that place for a match, and when he has struck it, then, of course, there is an end of it.

1990. With regard to the quantities allowed to be in a building, do they include powder in process of removal from or to the building?—Yes. Section 24 of the Act says, "All gunpowder and ingredients within the radius of 20 yards from the buildings, and in course either of removal from the building or of removal to the building for the supply and work thereof, shall be deemed to be in the building; provided that if while the gunpowder or ingredients so in course of removal are within the radius every machine and manufacturing process in the building is wholly stopped, these may, in addition to the quantity so allowed as aforesaid to be in the building, be within the radius, a further quantity of gunpowder and ingredients so in course of removal as aforesaid not exceeding the quantity specified in that behalf in the licence, or in the case of an existing building in a lawfully existing factory for gunpowder, 10 cwt." That is to say, that all gunpowder within 20 yards of a building is considered to be in the building.

1991. Is there any statutory obligation on the occupier of a factory to take all due precaution for the prevention of accident irrespective of specific rules directed to that end?—Yes. Section 23 of the Act lays down that, "The occupier of every factory, magazine, store, and registered premises for gunpowder, and every person employed in or about the same, shall take all due precaution for the prevention of accidents by fire or explosion."

1992. Have Her Majesty's Inspectors any power of requiring the abandonment or alteration of any practice which in their judgment may be dangerous?—Yes. under Scetion 56 of the Act we have power to require the occupiers of factories to discontinue any operation which we may consider dangerous; if the occupiers object to our ruling they may appeal to arbitration, but, as a matter of fact, we have never had such an appeal.

1993. Do you ever have occasion to require the discontinuance of any operations?—Yes, and the manufacturers, as a rule, are only too glad to have such things pointed out to them.

1994. Is it your practice to interfere, as a rule, with machinery in use, or do you limit such interference to cases where a machine may appear to you to be actively dangerous?—Only where it is dangerous; we then call the manufacturer's attention to the matter and he has to discontinue it, or appeal.

1995. Have you had an opportunity of looking at some of the rules in use at Waltham Abbey, especially those called the general rules and the rules relating to the cam houses?—Yes, there are some very good rules among them, but I think they are generally capable of improvement; in fact, there are certain points in which I think considerable alterations and improvements are required. For instance, in the general rules, No. 2 says "Matches are on no account to be brought into any part of the works or grounds," but they must have matches for lighting the engine fires. That rule requires amplification because at present it must be broken, and it is no use making rules which cannot be observed. Rule 4 deals with changing shoes, but it does not say where the clean shoes are to be left. Then again, men should be required to submit to being themselves searched in going in or out, but Rule 7 does not seem to provide for that.

1996. Do you consider that every man ought to be searched?—Yes. His pockets should be turned out and shown; it ought to be a real search. Rule 13 provides for the cleaning of the exterior of the powder houses, but it does not seem to provide for the same in regard to the interior, though I notice that that is dealt with in the cam-house rules. Rule 23, dealing with the mats, requires alteration; in fact, mats should be altogether forbidden. I notice also that there is no prohibition in these rules with regard to pockets, nor is there any rule providing that oiled cotton waste should be taken out of a building immeddiately it has been used. There does not appear to be any rule providing for the observance of the limit of explosive in a building, as specified in the notice posted up; nor is there, apparently, any rule that if gunpowder is spilled on the floor it shall be at once swept up. There is no rule referring to the meals, nor any rule forbidding anyone to enter a danger building in which he is not employed. We find men do go into buildings in which they are not employed, and that is not only a risk to themselves, but also to the men who are employed at the time in the building. There is no proper rule as to repairs, nor with reference to machines when they are defective. When that happens a machine should be at once stopped, and on no account should work be resumed until the foreman has given his permission. There ought to be a rule (it goes without saying) that if a person on coming back to work appears to be in any way intoxicated, that person should not be allowed to remain. Generally, I think, the present rules are a little too much mixed up, though it would be possible to have very good rules based upon them. There should be one part of the rules applying to the factory generally, and another part applying to the danger buildings, and then, if necessary, others applying to the particular houses.

1997. In regard to the limitation of the number of workpeople allowed to be in a building, can you give the Committee any information as to the maximum number allowed to be in buildings where gunpowder is compressed into pellets or prisms?—We would not allow more than six under any circumstances. Here is a list of the different factories which have houses such as you mention, showing the number employed in each [handing in the same, *vide* Appendix IX.].

1998. The object of any such limitation is, I presume, to prevent an unnecessary number of persons being involved in a single disaster?—Yes.

1999. Then may we take it that you consider the number present in or at the cam house at Waltham at the time of the explosion, viz., 11, was unduly large?—Yes.

2000. *Sir F. Abel.* There were two separate houses?—So far as we are concerned we consider it only one house, because it is all under one roof.

2001. Have you had instances of powder being brought in to a danger building by a boatman?—Yes.

2002. Would you include him in the number allowed in a building?—No. Recently we have made provision in the licences that, in addition to the workpeople, there may be "service waiters," as we call them, that is the men who bring in the powder and take it away, but a boatman would not be allowed to go into a building; all he could do would be to pass the powder out of the boat up to the outside of the building.

2003. *The Chairman.* Do you think it right that the powder should be carried or rolled on the chine of a barrel into a house whilst the machines are work?—Yes, I see no objection to that.

2004. When you fixed the quantities of gunpowder, I suppose the limit of explosive allowed to be in a house was made to bear some relation, not only to the requirements of the house, but also to its distance from other buildings?—Yes, the distances are shown in the line marked "workshop" in the table which I have already handed in (*vide* Appendix XIV.).

2005. *Sir F. Abel.* Are the distances the same whether the place is planted with trees or not?—Yes, but we have always encouraged the planting of trees.

2006. *The Chairman.* Then apparently the object of the limitation is to prevent the communication of explosion from one building to another?—Yes.

2007. Does your department attach considerable importance to the lining of danger buildings with some material, such as wood?—Yes, in all cases they should be lined throughout with wood, and, moreover, they should be kept painted or varnished; that provision is in all the licences recently granted, and in the general rules there is a stipulation that there shall not be any exposed iron.

2008. Do you consider that a building having an unlined slate roof is an improper construction for a danger building?—Yes, certainly.

2009. Do you think it desirable that such instruments as steel spanners, which may be needed for purposes of repairing or adjusting the machinery, should be allowed to be kept in the houses?—No.

2010. Would you approve of the use of a steel spanner for whatever purpose while the house contained explosives?—It might be impossible to get any other metal hard enough for the purpose; we should then be obliged to allow them to use a steel spanner, but we should take every precaution to see that it was covered with leather, so that if it fell it would not cause an explosion.

2011. Can you give us a reference to any accident or accidents due to a steel implement in a danger building?—Here is a list of such accidents [handing in the same, *vide* Appendix VIII.].

2012. *Sir F. Abel.* Would you allow steel spanners to be used while a machine was, more or less, charged with powder?—No, not under any circumstances.

2013. It should not only be free and empty of powder, but it should be cleaned down?—Yes, certainly.

2014. *The Chairman.* Is nightwork common in powder factories?—Yes, and where there are mills it is practically universal, because the output of a factory depends upon the number of mills kept going. In glazing-houses also they work at night, but there is no one required to attend them.

2015. Do you consider that such work can be safely carried on if properly and efficiently supervised?—Yes, I think so; we should not object to nightwork.

2016. Do you think that the night visits of persons charged with the inspection of the various buildings should be checked by tell-tale clocks?—Yes; I am afraid if they are not checked, they lapse.

2017. Do you insist upon that?—No, we leave it to the proprietors of the factories, and in the larger factories there are such clocks.

2018. *Sir F. Abel.* Do you interfere at all with reference to the times at which the inspections should be made?—No.

2019. Then, so far as you are concerned, a man may visit early in the night and not go again?—Yes.

2020. *The Chairman.* Can gunpowder be exploded by friction when in contact with hard surfaces or particles of grit?—Yes, certainly.

2021. In your opinion, would there be any risk of explosion if a barrel of gunpowder were roughly dragged over a wooden floor having indurated powder upon it?—Yes.

2022. Would such risk be increased by the presence of gritty particles?—Yes.

2023. And correspondingly diminished by the floor being covered with leather?—Yes.

2024. It would be possible to explode it on a leather floor, would it not, if the barrel were dragged roughly?—Yes, if the temperature were high enough.

2025. Can you furnish us with any particulars of experiments which tend to show that powder may, under certain conditions, be readily exploded by a blow, without the presence of a spark or visible form of heat?—Yes, experiments were made some years ago with these results:—A 25-lb. weight was allowed to fall 2 feet upon small packages of gunpowder, consisting of about 5 grains of Government powder wrapped in tinfoil, so as the exclude the possibility of a spark reaching it. The packages were placed between two metal plates, and the blows struck as follows:—

Material of plates.	No. of blows.	No. of explosions.
Both plates steel	10	10
One plate steel, one plate brass.	10	4
Both plates brass	10	2
Both plates lead	10	No explosion, even when the fall was increased to 40 feet.

2026. Would a metal body raised by friction or otherwise to a temperature at which the naked hand could be borne upon it be capable of exploding gunpowder?—No, the hand cannot bear even 212 degrees fahrenheit, the temperature at which water boils, so that shows the utter impossibility of bearing the heat, about 560 degrees, at which powder explodes.

2027. Do you consider that an arrangement of a danger building which required every barrel of gunpowder brought into it to be lifted up a step, about 9 inches in height, at the doorway, satisfactory?—No, I think that is a very bad arrangement indeed, the powder is liable to fall and so is the man.

2028. Have any cases come under the notice of your department of explosions or accidents during the pressing of gunpowder into pellets or prisms, whether for cannon, or blasting, or small arms?—Yes, here is a statement with regard to that [handing in the same, *vide* Appendix X.].

2029. *Colonel Lloyd.* Are you acquainted with the relative positions of the Waltham Abbey powder buildings?—No, I have been over the factory a very large number of times, though not of late years, but I have never looked at the buildings critically, *qua* their distances from one another.

2030. Then you have formed no opinion as to whether the distance and the quantities of powder kept in those houses conformed to the regulations you have referred to?—No; but as distances and amounts go hand in hand, if I knew the amount allowed in any building I could say the distance it should be from the other buildings.

2031. In private factories is there any system of inspection that would prevent the distances being reduced, or the quantities increased, beyond the prescribed rules?—If on visiting a house we found too much in it that would form the subject of proceedings unless there were some very good reasons for not instituting proceedings.

2032. Do you think there would be any danger of spontaneous combustion from a small number of sponge cloths, or from a small quantity of oily waste which was in continual use?—Yes.

2033. Say six sponge cloths?—Even with small quantities there is a liability of explosion, and so particular are we upon that point that we have insisted upon their getting rid of every bit of cotton waste directly after using it.

2034. Then where a machine constantly requires the use of material of that sort would you have it removed from a danger building?—Yes; put into a box outside, and brought back again as required.

2035. Do not you think there would be more danger in that course than in keeping it in the house?—No; it could be kept outside in a special box into which grit could not penetrate.

2036. In the case of a danger building, where they are at work day and night, would you think it necessary to periodically remove the oily waste?—Yes, it should be removed every night.

2037. Do you think it would be necessary to have two receptacles, one for the dirty oily waste that could not be used again, and the other for the oily waste that could be used again?—The dirty waste might be at once taken to the engine room and burned.

2038. Would you permit the use of clean movable boards in the shoe room?—I have never seen such an arrangement; if I did I might not object to it, but it seems to me to be quite unnecessary.

2039. A shoe room would always be dirty, I presume?—Half dirty and half clean, with a barrier in between; but I do not think that there should be little clean islands, so to speak, on the dirty part.

2040. But, *primâ facie*, you think the practice of having such movable boards objectionable?—I think so.

2041. Is it the custom in danger buildings that are covered with hides to have them washed out at frequent intervals?—The hides are wetted from time to time, but I cannot say how often they are washed; the important point is that they should be clean.

2042. Is there any good reason against wetting the hides; are they liable to become ingrained with powder dust?—I do not know.

2043. Would you be satisfied with their being constantly swept?—I think they may be wetted.

2044. One witness has said that if the hides were wetted there would be a continual efflorescence of saltpetre on the surface when they dried?—I have not found any such thing.

2045. Would there be any objection to an efflorescence of saltpetre?—No.

2046. In a very dusty house where hides were used, do you think that the effect of their being wetted would be likely to attract more dust into the substance of the hide, and thus cause the danger which we desire to prevent?—I am not able to say how far wet would penetrate into a hide that was properly tanned. I should think in that case the wet would continue on the surface; but any way, if it is wetted only by washing, then I think the penetration would be very small.

2047. Are hides generally used in danger buildings?—Yes, in many of the best factories.

2048. And are wood floors always used where there are no hides?—Yes; sometimes lead is used, in the case of stoves for drying powder, but as a rule lead is going out of fashion.

2049. Do the regulations require that the roofs of danger buildings should be lined?—Yes, the whole of the interior.

2050. There are many cases in which traverses faced with brick have been erected between contiguous danger buildings. Are the bricks so liable to disintegration as to render it probable that pieces will fall into the building?—We should never allow exposed bricks to be on the inside of a building; we require them to be covered with wood.

2051. *The Chairman.* Would you approve of the foremen periodically searching the men in their gangs?—We should certainly approve of that. In the best factories there is a system of reports, more or less elaborate, upon that, but it is a matter in which we do not interfere. If we find the work is properly done, and things are in proper order, we leave the manufacturers as much as possible to themselves.

2052. If you knew of a factory in which there was not a written report, would you consider their system faulty?—Yes; and if an accident happened I should call very prominent attention to it.

2053. *Sir F. Abel.* With regard to the searching in private factories, are books kept in which the foremen have to record the fact that they have searched the workmen in the different buildings?—In the better regulated factories reports are filled in by the foreman, and they are put into a book.

2054. Is that book always open to your inspection?—Yes. In fact, when, after an accident has taken place, we want to know when the workpeople were searched we go to that book. In some cases the men keep their private clothes in lockers, but the foreman has a master key of all the lockers, and he can go to one and search the clothes when he wishes.

2055. Are the details with reference to the searching of clothes left to the judgment of the owners of the factories?—Yes.

2056. *Colonel Lloyd.* Are the reports in the private factories made for the purpose of securing the safety of the buildings and their contents, or for ensuring that a proper amount of work is done by the men, or for both?—I think both to some extent.

2057. *The Chairman.* With reference to the oiled rags, I understand you would not allow any to be kept in the place where the powder is?—If I saw an oiled rag lying not in use in a danger building, I should at once have it put out, and want to know why it was there; I should call attention to the rules, and possibly threaten proceedings.

2058. If you found out that it was the habit to leave those lying about, clearing them out only once or twice a-week, would you consider that faulty?—Yes, it could not be worse.

2059. Is there anything else you desire to bring before the Committee?—Yes. A circular letter was some short time ago addressed to the different manufacturers asking whether in their manufacture of the present powders accidents had occurred, and if so, would they give us the details. Here is an abstract of their replies [handing in the same, *vide* Appendix XI.].

2060. Does that correspondence refer to heating of machines?—I cannot say.

(*The Witness withdrew.*)

APPENDICES.

SUBJECTS.

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APPENDIX I.

Royal Gunpowder Factory, Waltham Abbey.

Structure of No. 2 Cam House.

General.

The building consisted of three compartments—

1. The southern one, containing Nos. 2 and 3 cam machines;
2. The central one, containing the water-wheel; and
3. The northern one, containing Nos. 4 and 5 cam machines.

The inside dimensions of these compartments were, approximately—

1. Southern, 26 feet by 17 feet 6 inches.
2. Central, 9 feet 8 inches by 17 feet 6 inches.
3. Northern, 24 feet by 17 feet 6 inches.

Communication between them was along a covered platform, from either end of which an open platform led down to the river. Both these platforms were "clean," and their relative positions and those of the various doors are shown on the Plan.

Walls.

The south wall of the building was of brick, 18 inches thick at the ends and 22½ inches thick between the side walls of the building. The other walls of the house were of wood framing, covered on the outside with weatherboarding and on the inside with ¾-inch matched boarding, all copper-nailed. The south end brick wall was also lined with matched boarding. The outer wall of the covered platform was weather-boarded and copper-fastened, but not match-lined.

Roof.

Wooden trusses covered with tarred felt on boarding. A lining of matched boarding, copper-fastened, was fixed as a ceiling under the tie-beams of the trusses. There were some iron screws in the roof trusses outside the lining, but none that could have fallen into the house until after the lining was burned. Height of eaves above floor, about 10 feet. Pitch of roof, 45 degrees, fitted with copper lightning conductor.

Floor of North and South Compartments.

1¼-inch boards, covered with hides, copper-fastened.

Floor of Covered Platform.

1½-inch boards, ploughed and tongued, copper-fastened.

Open Platforms.

2-inch boards, laid with ½-inch space between them, copper-fastened, fitted with fender boards and handrails.

Doors.

All opened outwards, and swing-doors were fitted with lead weights running in casings and gunmetal pulleys.

Lighting.

Outside electric lights.

M. T. SALE, *Colonel.*
Superintendent, Building Works Department.

3rd March, 1894.

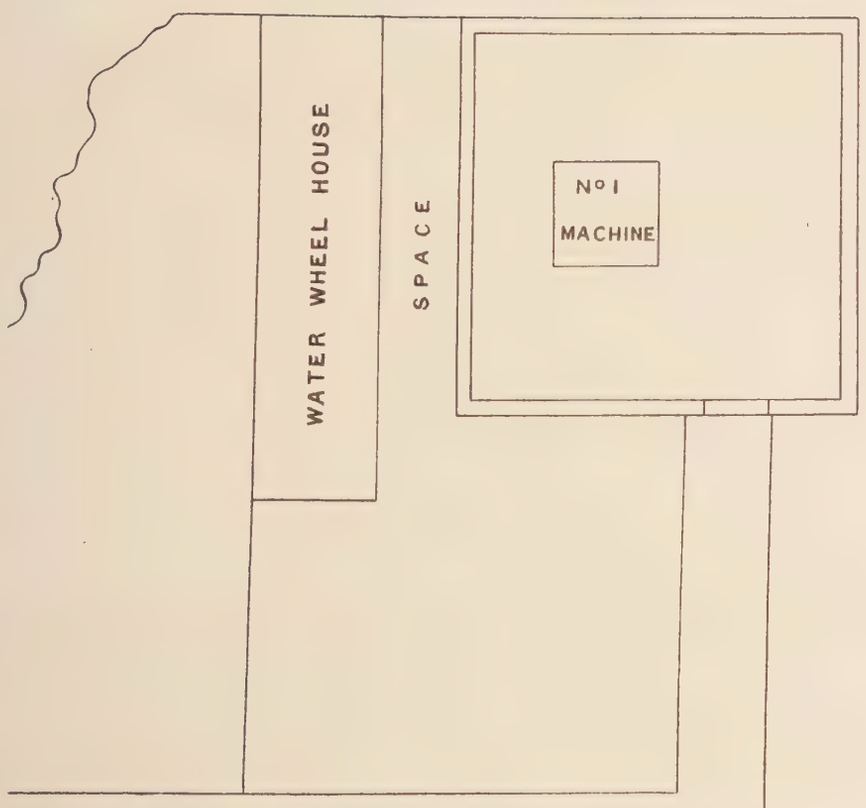
PLAN OF No. 2 CAM HOUSE, ROYAL GUNP

(DETAILS OF MEASUREMENTS, Etc., ARE

T A I L

POSITION OF CAM HOUSES

Nos. 1 AND 2 LOWER ISLAND.



REFERENCE

A to A'.—Brick Wall.

B to B'. Route by which barrels of powder were being brought on the night of the accident from the boat to the South End of the house

B'. A Step of about 9 inches up to the floor of the house.

C, D, E, F, G, H, J, K.—Doors opening outwards.

c, d, e, f.—Wells or recesses about 9 inches below the level of the floor of the house in which were dirty mats (Questions 1,444, 1,535-6, 1,748).

g, h, j, k.—Ditto, in which were clean mats (but see Question 1,749)

L.—Spot where Watts's hand was found (Question 1,189).

M.—Electric light, lighting the platform.

N. 2, 3, 4 and 5.—Positions of the tables at which the men working in front of the machines, so numbered, placed the prisms on the racks.

P^2, P^3.—Alleged positions of seats of men working behind Nos. 2 and 3 machines (Questions 1,591-2, 1,777-83).

N.B.—The positions assigned on the plan to the men are those which they occupied at the time of the first report or explosion; that assigned to Watts, the only man who did not get away from the building, being that where his body was found. According to one witness, Watts's body was found nearer the machines. (Questions 1124-5.)

SOU

END

H E A D S

(875.5/94.1120.) 45.W.O.

Harrison & Sons Lith. St Martin

OWDER FACTORY, WALTHAM ABBEY.

(E SHOWN ON SEPARATE SHEET.)

S T R E A M

TH

NORTH END

A

C D E F

C | N2 | N3 | D | E | N4 | N5 | F

Clayden · Larman · Jennings · Skinner · Bailey

No 2 MACHINE · No 3 MACHINE · No 4 MACHINE · No 5 MACHINE

WATER WHEEL

Rudkin · Rudd · Massey · Carr

B'

K · P2 · Watts · P3 · J · H · G

K J H L G

SHOE ROOM

COVERED CLEAN PLATFORM

M

A'

CLEAN PLATFORM

CLEAN PLATFORM

B

Hare

PLATFORM ON END OF BOAT

SLIDE OPEN

HOUSE HOUSE

SLIDE SHUT

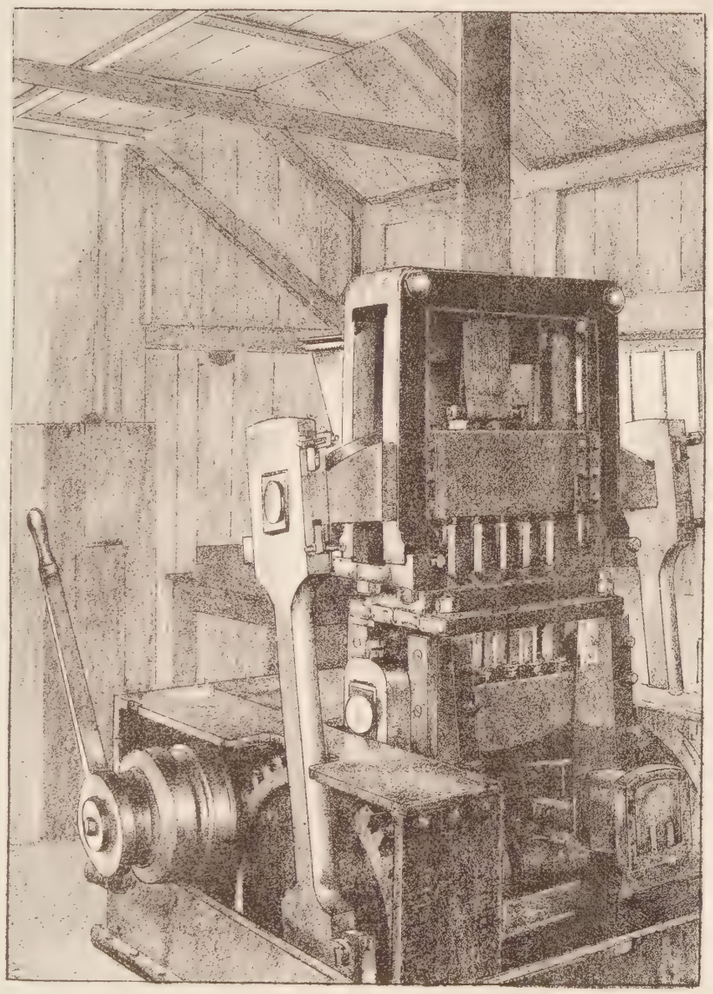
PLATFORM ON END OF BOAT

Magazines ⟶ 141·5 Feet.

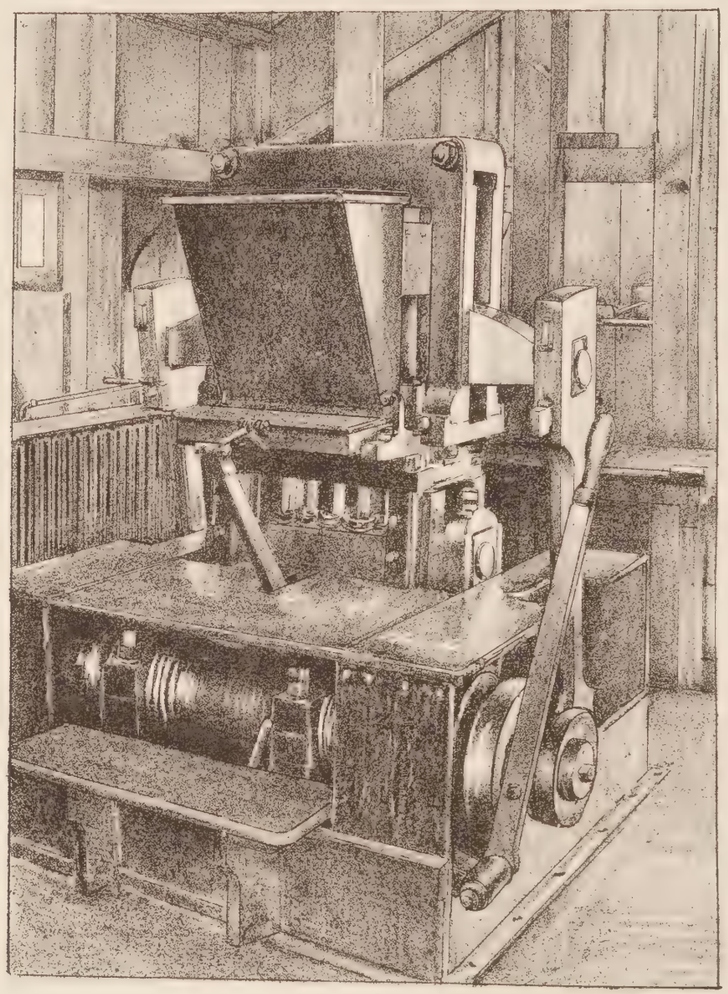
T R E A M

VIEWS OF No. 1 CAM MACHINE.

FRONT VIEW.



BACK VIEW.



The front view, above, shows the cross-heads carrying the top and bottom plungers respectively. The plungers have met in the matrices or bushes and are pressing the powder into prisms.

The back view shows the charger or carrier brought back under and receiving the charge from the hopper.

(675 5/99. 1120) 45 W.C

Harrison & Sons Lith. S. M[illegible]

Fig. 1.

Fig. 2.

Fig. 3.

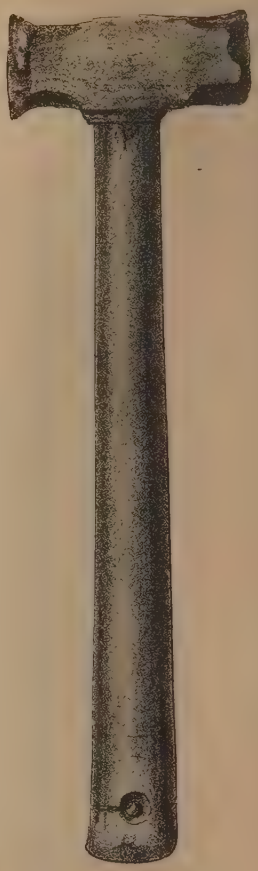


Fig. 4.

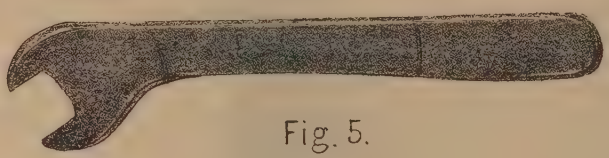


Fig. 5.

Fig. 8.

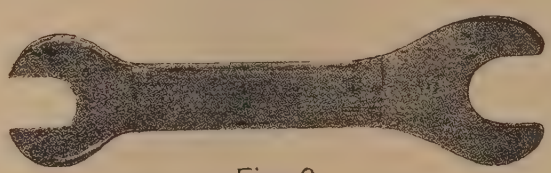


Fig. 6.

Fig. 9.

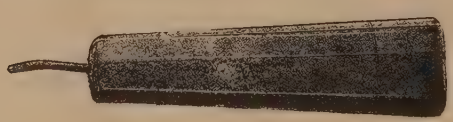


Fig. 7.

Fig. 10.

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APPENDIX II.

Description of the Cam Machine as used in the Royal Gunpowder Factory, Waltham Abbey.

This machine is fitted with six plungers and works automatically.

The press virtually consists of a matrix-table (or bush-block) containing the matrices or "bouches" (bushes), and of two movable cross-heads carrying the plungers. The former is fixed to the frame, and the cross-heads are set in motion by rods connected with the eccentrics fixed on the right and left of the machine.

At each revolution the cross-heads approach one another—and with them the plungers—to within a minimum adjustable distance of each other, both upper and lower plungers entering the bushes and compressing the powder. In the centre of each of the lower plungers is a pin which pierces the centre of the prism during the pressure.

As soon as compression is completed the upper plungers are withdrawn, while the lower plungers continue sliding through the bushes, and force the prism of powder to the surface of the matrix-table (or bush-block).

The machines in use at Waltham Abbey are so worked as to complete four compressions a minute.

A plate (or charger), which slides on the matrix-table, and which is connected with a hopper on the back of the machine, serves to fill the matrices (or bushes), and, at the same time, to remove the prisms of powder as they emerge to the surface of the matrix-table (or bush-block).

The eccentrics are connected with two friction wheels fixed to the axle of the machine, and working in two other friction wheels of the main shaft.

The plungers and the pins are made of phosphor-bronze, which is also used for the lining of the matrices or bushes. The cross-heads and the other parts of the machine are made of steel. All light parts are now painted since the accident.

APPENDIX III.

Description of Tools that were used in Cam House, No. 2.

Fig. 1.—"Steel tongs," 10⅛ inches long, ¾ inch wide at the gripping part. Shanks taper down to ⅜ inch diameter; weight, 1¼ lb.
Used for removing pins from pin blocks.

Fig. 2.—"Steel screwdriver," with 2 driving points, one at right angles to the other. Length, 6⅜ inches; width of driving point, ¾ inch; width of handle, 1 inch; thickness, ⅜ inch, tapering to ¼ inch; weight, 9½ oz.
Used for removing and tightening steel screws that secure plungers to cross-head.

Fig. 3.—"Tool, ½-inch round bit," made from a piece of an old phosphor-bronze pin, with a tee bar of delta metal for a handle. Length over all, 6¾ inches; length of handle, 3½ inches; diameter of handle, ⅝ inch; diameter of tool, ⅜ inch base; weight of tool complete, 8½ oz.
Used for cleaning pin holes in top plungers, after using "cane rod."

Fig. 4.—"Gunmetal hammer," with wood shaft; head fairly worn. Length of head, 3½ inches; sides of head 1¼ inch square, with corners chamfered; length of shaft, 12 inches; weight of tool complete, 1 lb. 11½ oz.
Used for adjusting keys in connecting rods.

Fig. 5.—"Gunmetal spanner," single end. Length, 8⅝ inches; width of jaw, 1 3/16 inch; width of handle, 1 inch; thickness, ½ inch, tapering to ⅜ inch; weight, 1 lb. 1 oz.
Used for adjusting keys in connecting rods.

Fig. 6.—"Iron spanner," double-ended. Length, 7¾ inches; thickness, ½ inch, size of large jaw, 1 inch; size of small jaw, 13/16 inch; weight, 1 lb. 1 oz.
Used for removing or securing screws of pin blocks to pin plate.

Fig. 7.—"Bronze awl," made from a piece of phosphor-bronze wire, driven into a wood handle. Length of awl, 1¼ inches; diameter of awl, ⅛ inch; length over all, 6½ inches; weight, 2¾ oz.
Used for clearing water-way in bottom plungers.

Fig. 8.—"Delta metal drift." Length 4 inches; diameter, ¾ inch; weight, 8½ oz.
Used when adjusting keys of connecting rods when being struck by hammer. The drift is held in the left hand against the key, while the hammer in the right hand strikes the blow; the drift being between the hammer and the key.

Fig. 9.—Bronze wire, flattened at one end, and a ring formed in the other. Length, 5 inches; diameter, ⅛ inch; weight, ½ oz.
Used for cleaning out oil holes.

Fig. 10.—"Cane rod." Length, about 22 inches; diameter, 5/16 inch; weight, about ¾ oz.
Used for washing and clean top plungers, and holes through top crosshead. The cane is passed through, and worked up and down while the water is being passed down.

NOTE.—Nos. 2 and 6 should have been kept in cupboard in shoe room, and only used by mechanics: one of each of the other tools was kept in the cam house for the use of the men when the machines required washing out.

W. McCLINTOCK, *Colonel,*
Superintendent Royal Gunpowder Factory.

ROYAL GUNPOWDER FACTORY,
14*th March*, 1894.

APPENDIX IV.

RETURN of the Number of men searched by Police when entering or leaving the Royal Gunpowder Factory, Waltham Abbey, from January, 1893, to 28th January, 1894.

Weeks ending.	Number Searched.		Remarks.
	Entering.	Leaving.*	In each case the man was stopped on entering the factory.
1893.			
1st January	336	229	
8th „	474	279	
15th „	496	201	
22nd „	520	258	One man stopped, drunk.
29th „	519	210	
5th February ..	508	264	
12th „	542	282	
19th „	523	329	
26th „	533	343	
5th March	338	249	
12th „	497	235	
19th „	470	307	
26th „	499	320	
2nd April	313	209	
9th „	359	209	
16th „	438	249	
23rd „	416	266	
30th „	395	264	

* The men are searched when leaving the factory, with a view to see that they are not in improper possession of Government property.

RETURN of Number of men searched, &c.—*continued.*

Weeks ending.	Number Searched.		Remarks.
	Entering.	Leaving.*	In each case the man was stopped on entering the factory.
1893.			
7th May	464	251	
14th „	453	294	
21st „	459	263	
28th „	230	133	
4th June	271	334	
11th „	474	243	
18th „	434	247	
25th „	476	281	One man stopped, with matches.
2nd July	386	285	
9th „	494	294	
16th „	503	331	
23rd „	506	381	
30th „	494	353	
6th August	465	373	
13th „	434	241	
20th „	520	265	
27th „	542	360	
3rd September ..	559	255	
10th „ ..	569	314	
17th „ ..	556	357	One man stopped, with a match.
24th „ ..	590	302	
1st October	495	380	
8th „	574	312	
15th „	469	303	One man, drunk.
22nd „	542	271	
29th „	539	317	One man, drunk.
5th November ..	592	323	
12th „ ..	536	418	
19th „ ..	565	383	
26th „ ..	542	383	
3rd December ..	602	416	One man stopped, with three matches.
10th „ ..	682	505	
17th „ ..	582	464	E. Larman and B. Hare, searched 11th December. W. Watts, searched 12th December.
24th „ ..	577	377	
31st „ ..	360	253	
1894.			
7th January	600	349	
14th „	621	307	One man stopped, with box of fuzees.
21st „	1,082	365	Four men stopped, with matches and one man with pipe.
28th „	1,093	370	
Totals	27,308	17,356	

* The men are searched when leaving the factory, with a view to see that they are not in improper possession of Government property.

RETURN of the Number and Names of men stopped with matches, &c., in their possession, from January, 1893, to 28th January, 1894.

Names.	Date of Entrance.	Date of Discharge.	Remarks.
S. Woollard	27th November, 1891 ..	16th January, 1893 ..	Drink.
W. H. Ellis	22nd June, 1893	24th June, 1893	Matches.
J. Howard	25th January, 1886 ..	11th October, 1893 ..	Drink.
J. Walker	6th July, 1893	25th „ ..	Drink.
W. Skinner	10th August, 1891 ..	15th September, 1893 ..	Matches.
A. Gossett	2nd November, 1893 ..	27th November, 1893 ..	„
Ed. Steed	1st January, 1894	13th January, 1894 ..	„
J. Chesham	11th December, 1893 ..	15th „ ..	„
J. Appleton	2nd January, 1894. . ..	„ „ ..	„
W. Poulton	„ „ ..	„ „ ..	„
A. Morris	„ „ ..	„ „ ..	„

APPENDIX V.

ROYAL GUNPOWDER FACTORY, WALTHAM ABBEY.

A.

General Rules.

1. Smoking is strictly prohibited in any part of the grounds, roads, or houses, belonging to the factory.

2. Lucifer matches, cigar lights, or other combustibles, are on no account to be brought into any part of the works or grounds.

3. Men are forbidden to carry keys, knives, or other articles of iron, when employed in or about the houses, mills, or boats. If from the nature of their employment any knives or tools are required, they will be supplied.

4. Before going to work in any "clean" house, mill, or boat, men are to change their own clothes in the shifting room appointed them, and put on the working dress of black lasting provided for the purpose; they will change their own boots for magazine shoes at the barrier, before entering any "clean" house, mill or boat. On leaving work they will resume their own boots and clothing. Trowsers of working dress are not to be turned up, as small stones and particles of grit are likely to be carried into the houses thereby. The working clothes supplied to men and boys of the guncotton branch are intended to protect their own clothing from acid, and are only to be used whilst at work in the factory.

5. As shifting rooms have been provided in which men will leave their own clothing, and put on that provided for them, no clothes are to be kept about the several workshops, lobbies, boiler houses or engine rooms. This rule will not apply to the guncotton, machinery, or refinery department, or to millmen at steam mills, or stokers at stoves.

6. No person is to enter or leave the factory except by the main and refinery entrance gates; those individuals having keys of the works are on no account to use them except for themselves, when on duty. In case of an accident happening, they are authorized to admit those who are employed in the factory, should their services be required, but none others.

7. Men employed in the factory are to remember that they are bound to answer civilly all questions put to them by the inspector of police, serjeant, or constable, on duty at the gates, as to the contents of bags, &c., or any articles taken by them in or out of the factory. The police have orders to search and examine from time to time persons taking anything in or out of the gates.

8. All persons employed in the factory are cautioned not to answer enquiries from strangers, with regard to any of the arrangements of the factory. No information with respect to these arrangements must ever be given to unauthorized persons.

9. No workman employed in the factory is to enrol himself in any of the Reserve Forces without the permission of the Superintendent.

10. Instances having occurred of men rupturing themselves while lifting boxes or barrels of powder, all concerned are cautioned against lifting any heavy weight while the feet are apart. The danger of rupture is greatly lessened by keeping the feet close together.

11. Men employed in handling gunpowder or its materials, in any stage of manufacture, must be careful to keep their hair and beards cut short, in order to lessen the risk of introducing particles of sand or grit.

12. Men employed in powder houses are specially cautioned to carry on the work entrusted to them in as careful and gentle a manner as possible. No undue haste must ever be made, and no greater force employed than is absolutely needed to effect the object in view. It must be remembered that a degree of friction which may be safely endured by powder alone, might cause accident if by chance any foreign substance has become mixed with it.

13. The greatest care must be taken to keep the platforms, floors, and exterior of powder houses and boats perfectly free from dirt or grit. The platforms and outsides of houses should be constantly wetted in dry weather.

14. No implements are to be used in any powder house, mill, or boat, except those provided, and these tools are to be handled carefully, and never to be thrown down violently.

15. Open powder barrels and charge tubs are always to be rolled on their chines, and *never dragged* along the platforms or the floors of houses or boats; they are never to be placed one in the other when filled with powder, but each rolled separately.

16. Special care must be taken to redouble every precaution during the prevalence of hot dry weather, when particles of sand or grit are more likely to be blown into the houses, or to be carried about in men's dress or hair than at other seasons.

17. When a thunderstorm is seen passing over the factory, the men employed in powder houses, mills, or boats, are carefully to close the window shutters and doors, stop the machinery, and quit the vicinity of such houses, mills, or boats, until the storm has passed.

18. All foremen and men of the factory are to obey, without hesitation, the orders of the chief foremen, or their assistants; in the same manner, the men are to obey the foremen placed immediately over them. Should a man consider himself aggrieved, he can afterwards make a complaint to his chief foreman, who will bring the case to the notice of the assistant superintendent.

19. There is no thoroughfare past No. 1 Mill, or on the mill head; no men are allowed to pass that way except those whose duties oblige them to do so. The men employed at the barrel houses must go round by the long walk.

20. Men employed in "clean" houses, mills, or boats, will be searched by the foremen under whom they work, after they have put on their lasting clothes. The foreman will report daily having carried out this order.

21. Greatcoats are only issued to those men whose duties necessitate their being much exposed to bad weather when wearing powder clothes; they are never to be taken out of the factory without special permission from the Superintendent. When not required for use, they will be hung in the main shifting room, or other place allotted to the wearer for changing his clothes. In bad weather, when not actually worn, they may be hung in the lobbies of the houses in which the wearers are employed, but are to be restored to the shifting rooms after the work is over.

22. Magazine shoes will only be issued to men employed in "clean" houses and boats; men of the store and machinery branches will only wear them when actually employed in "clean" houses.

Worn magazine shoes may be issued to the foreman and men of the cylinder, sulphur, and saltpetre houses, only to be worn by them while actually at work.

Goloshes, or overboots, are to be in charge of the master-worker, and shown on the "use lists" of houses; they are intended for the use of persons entering powder houses casually, and are never to be worn by the workmen.

23. Mats will be placed just within the *outside* doors of the lobbies of "clean" houses, and not inside "clean" houses themselves; they will be very frequently removed for shaking.

24. No person employed in the factory, either permanently or temporarily is permitted to remove bundles of chips or shavings from the grounds of the factory. At the completion of a job, or when otherwise authorized, they may be taken away in bulk, with a pass duly signed.

25. Persons occupying Government cottages, whether rent free or on payment, are prohibited to receive any inmates, except the wife and children of the tenant, without the express sanction of the Superintendent. All incoming tenants are to sign an agreement to this effect.

W. McCLINTOCK, *Colonel*,
Superintendent.

B.

Rules for Cam Houses, Lower Island.

1. Before work is commenced, the foreman on duty will examine all the machinery, and see that everything is "clear" before starting the machine.

2. Great care must be taken to prevent any undue straining of the machine, as a neglect of proper precaulons has led to serious accident. The men working the machine must perform their duties with vigilance, and they will be held responsible should any accident happen from their neglect.

Attention is called to the following precautions;—

It is most important that no grain beyond the proper quantity is in the "bouches" when a pressing is commenced.

The hopper of the machine should be emptied before cleaning down.

When starting afresh, the machine should first be run several times with the hopper empty, and stopped so that the chargers are over the dead plate. The hopper should then be loaded up and the machine started.

If this be done, a larger charge than that given by the natural motion of the machine cannot get into the "bouches."

After any stoppage of the press, from whatever cause, the grain in the charging rings should be partly taken out before the machine is again started. Care must be taken that there is no obstruction to its free working on starting, and that at all times the prisms delivered from the "bouches" are properly discharged down the machine and clear of the return stroke of the top plungers. If the prisms hang back from any cause the machine must at once be stopped.

If there be any suspicion of undue straining, due to any cause, the machine should be stopped, and the circumstance reported to the master worker or the foreman of machinery at the Lower Island.

3. The quantity of powder in the house for each cam machine must never exceed 200 lb.

4. No gunpowder is to be kept in the house when not at work.

5. The floors must always be kept cleanly swept, and no powder dust is to be allowed to accumulate in the house or on the machinery.

6. No person, except those who are properly instructed and duly authorized, are at any time to meddle or interfere with the machinery.

7. Any defect in the machinery, or any repair required, should be at once reported to the master worker and to the foreman of machinery, Lower Island.

8. The foreman is responsible that the moulding records are duly entered in the book provided for the purpose.

W. McCLINTOCK, *Colonel,*
Superintendent.

C.

Extract from the *Rules and Regulations of the Ordnance Factories.* A copy of which is in the possession of each workman employed.

47. Workmen are to render implicit and unhesitating obedience to the orders of the foremen, or others, under whom they are employed. They are also to obey the orders of the warder. Any act of disobedience or insubordination will lead to the immediate suspension of the offender, and, in aggravated cases, to his dismissal.

48. Machines are not to be cleaned when in motion. Workmen are strictly forbidden to replace bands on main shafting unless specially authorized by their forman to do so. Any person, other than those so authorized, who shall be detected in replacing or removing bands, will be liable to dismissal.

49. Any man coming to his work intoxicated, or known to lose time through intemperance, will be discharged.

50. No employé is permitted to keep a public house, beer house, or marine-store dealer's shop.

55. If any workman has any communication or complaint to make, he must do so through the foreman under whom he is employed. The foreman will at all times forward every complaint he may receive to the manager, who will investigate it, and, if he considers it necessary, report to the Superintendent. All complaints made in a proper and respectful manner will receive careful attention, and it is to be distinctly understood that every workman has a right of appeal to the Superintendent. Workmen are cautioned against making misrepresentations or frivolous complaints of any kind, or forwarding complaints through any other than the proper channel. Any infringement of this order will render the offender liable to dismissal.

57. Any workman who may inadvertently bring lucifer matches or other dangerous articles, or a tobacco pipe, into the works, should immediately deliver them up to his foreman, otherwise he will render himself liable to suspension or, on repetition of the offence, to discharge. Any workman found with such articles in danger buildings will be at once dismissed.

Smoking is, however, permitted to men on night shift when no danger is incurred thereby. Superintendents of factories will decide what men are to be permitted to smoke, and will specify places and hours for the purpose.

58. Workmen employed in danger buildings should make themselves thoroughly acquainted with the printed instructions in regard to the work, which are posted in the workshops, as ignorance of these will not be accepted as an excuse for irregularities.

APPENDIX VI.

Report from Colonel W. McClintock, R.A., Superintendent of the Royal Gunpowder Factory.

Royal Gunpowder Factory,
Waltham Abbey,
31st January, 1894.

Sir,

As directed, I now forward a short statement with reference to points 1 to 4 of Colonel Majendie's memorandum—

1. "Exactly when and how the accident occurred."

At 2.35 a.m., on the 13th December, 1893, an explosion, or rather two explosions, took place in the south end of No. 2 Cam House, Lower Island; and after a short interval the north end of the cam house exploded, as also the powder boat which was lying alongside. The two ends of the house were separated by a water wheel, and a wooden wall on each side of the wheel. In each end of the house there were two cam machines, two men working each machine. A foreman had charge of both ends of the house, passing from one end to the other along a clean covered passage in front of the wheel. The powder boat was worked by two men, so at the time of the explosion eleven men were present.

2. "The quantity of gunpowder, whether in the form of grains or prisms, which exploded or burnt."

The total amount of powder destroyed was 1,200 lb. It is believed that half of this amount was in grain and half in prisms, because it was the duty of the boatmen to bring the grain to the house and to remove the prisms already made.

3. "The effects of the explosion as regards (*a*) personal injury; (*b*) structural damage; and (*c*) injury to machinery, and other damage."

(*a.*) Of the eleven men present at the time of the explosion, one escaped unhurt, one was killed on the spot, eight died from shock and burns, and one is now doing well. List "A" gives the men's ages and length of service.

(*b.*) The explosion blew out the windows of the house, but as far as I could see did not damage the walls or roof. The house was set on fire, and was almost entirely consumed before the fire was extinguished.

(*c.*) The water wheel continued to revolve and to work the machines after the explosion, and was only stopped when the roof fell in and jammed it. Owing to this the wheel was quite uninjured by fire, as the fire was almost extinguished when the roof fell in. The cam machines were slightly damaged, one had a top plunger broken by a screw from the roof falling into the bush, and others had bushes damaged by prisms exploding in them. The boat had one-half of the hood blown away. Photographs of the house and machines have already been forwarded to you.

4. "The various possible causes of the accident."

The only possible cause of the explosion, that I can imagine, is, that in some way a match found its way into the house and was ignited by the powder barrel being rolled over it. As the machines were working at the time of explosion no repairs or alterations to them could have been going on. The machines were in good order, as proved by the evidence of the foreman of the day shift. The foreman of the night shift was a very careful trustworthy man, and would have seen that all regulations were carried out. I forward the result of examining 28 men who had been accustomed to work these cam machines (*see* Appendix VII). The electric light was outside the building, and the wind which was blowing a gale, did not come from the direction of any source of fire, besides heavy rain was falling, so I do not consider it possible that the fire came from any external source. Grit might have got into the building, but as nearly all the working parts of the machines are of phosphor bronze, a spark from this cause is not likely. The floor was covered with leather, so that even if some grit had got upon it, I doubt if rolling a barrel over it would have caused a spark.

I have, &c.,
W. McCLINTOCK, *Colonel*,
Superintendent.

The Secretary of the
Waltham Abbey Explosion Committee.

A.

List showing men who were killed or injured, &c., in the explosion at the Lower Island, Cam House No. 2, on 13th December, 1893.

Royal Gunpowder Factory, Waltham Abbey.

Name.	Employment.	Age.	Length of service at R.G.P.F.	Remarks.
		Yrs. Mths.	Yrs. Mths.	
Bailey, James	Foreman. ..	30 8	15 7	Died 19th December, 1893.
Carr, William John ..	Skilled labourer..	20 0	6 2	Injured.
Clayden, James	„ ..	22 5	7 5	Died 14th December, 1893.
Massey, Henry	„ ..	24 0	6 2	„ 13th „ „
Larman, Edward ..	„ ..	21 0	6 0	„ 18th „ „
Jennings, Henry ..	„ ..	28 0	2 3	„ 14th „ „
Rudkin, William.. ..	Labourer ..	23 0	2 1	„ „ „ „
Rudd, George	„ ..	25 0	1 3	„ „ „ „
Watts, Walter	„ ..	27 0	1 5	Killed on the spot, 13th December, 1893.
Hare, Benjamin	„ ..	21 0	1 1	Died 19th December, 1893.
Skinner, Henry	Skilled labourer..	35 0	6 3	Escaped uninjured.

STATEMENTS (in the form of Answers to certain Questions) of Workmen familiar with the Working

Name.	Present employment?	When employed in cam house?	At which machine employed?	How did the machine work?	Did you have any difficulty with		Did you find hot, that you on them?
					(*a*) Pins?	(*b*) Plungers?	
1. Adams, Samuel ..	Stores	About four years to summer 1891.	Foreman	Pretty fairly, on the whole ..	I don't recollect any difficulty with pins (gun-metal.) The steel pins used to score, and they were rather hard to clean at times. Never worked machine without getting water to run.	The top ones very seldom used to clog; used to stop and clean by probing or washing with hot water.	Never noticed never heard. The bush bl at end of ru not be born
2. Argent, Daniel.. ..	No. 3 breaking-down house.	For four or five months to Saturday before explosion.	No. 4	Pretty fairly, all but the pins..	At times ran warm	Top plungers got choked; freed with a cane, or removed and soaked in hot-water.	Never so hot them.
3. Beach, Alfred	Blending house ..	About four months. Worked up to 12th December, 1893.	No. 5	All right on 11th and 12th ..	Difficulty in getting water to run with the new pins the previous week. Foreman's orders were never to leave the pins until the water had been made to run, and had always made the water to run before leaving them. Left them all right on Tuesday the 12th by special orders of the foreman. Never knew machines restarted till water had been made to run.	..	Warm. Neve could not be for washing
4. Biss, Percy	Drum house	About five or six months to stop for new water wheel.	No. 2	Middling	Water would not run very well. Always got it to run before restarting the machine.	No	Nothing out o used for wa Never so ho them.
5. Brace, Alfred W. ..	No. 1 moulding house ..	Was boatman from April to August, 1893.	No. 2 when restarted in November.	Well, except when the new pin was put in about a fortnight before the accident. The machine worked well in the day shifts, Monday and Tuesday, 11th and 12th December.	None on the 11th and 12th. Water would not run freely when new pins were put in, but got it to run before restarting, although it took longer than usual. Never restarted without clearing the pins.	None	Always work that I coul them. Mu said they we ing out a accident.
6. Carr, Arthur H. ..	..	From starting of new water wheel.	No. 4	Very well	Just a little while to get water through sometimes, but always got it through before restarting.	No	No, except w boiling wat
7. Carr, Frederick ..	Chargeman, No. 4 moulding house.	About six months ..	Nos. 4 and 5.. ..	Very well	Nothing much; sometimes water would not run very freely.	None	Just warm, co on them.
8. Carr, Herbert	No. 4 moulding house ..	From a month before new water wheel was put in to 12th December, 1893.	No. 5	Very well	Yes, difficult to get the water to run down in cleaning out, but managed it after working some time.	None	Yes, but not bear my ha
9. Clarkhall, W.	Mixing house	Up to three months ago.	Nos. 1, 2, 3 and 5 ..	Sometimes well, sometimes troublesome.	No. 2, the worst, difficulty in getting water to run. Never restarted working until had got water to run.	Top plunger got clogged; removed and soaked in hot water.	Never knew t could alway
10. Ephgrave, George ..	Foreman of cam house..	From 17th April to 12th December, 1893.	..	Generally satisfactory	With new pins generally, a little extra trouble to get the water to run.	None	No, only warr hand on the
11. Eve, Alfred	Charcoal house.. ..	On day shift for about 8 months to day of explosion.	No. 3	All right	Last lot of pins the worst; very difficult to get water to run Never restarted machine without getting water to run.	None	Got warm, co them.
12. Guthridge, S.	Water millman.. ..	About six months to stoppage of old wheel.	Nos. 3 and 5.. ..	Very well, except that charger used to hang up.	Trouble at times to make the water run. Always got it to run before restarting the machines.	Top plunger sometimes got blocked; if it could not be cleared with the cane, removed it and soaked in hot water.	Warm, never hand on the
13. Hickman, A.	No. 3 granulating house	For three or four years to stoppage for new water wheel.	All	Pretty fair, except on prism brown. Charger used to hang up.	Difficult to get water to run. Sometimes took half-hour, but never restarted machine until had got water to run.	No; broke occasionally ..	Warm, not hands on t

f the Cam Machines in use at the Royal Gunpowder Factory, Waltham Abbey.

he pins get hot, if so, so could not bear your hand	Did you consider the machine dangerous; if so, in what way?	Did you ever complain about the machine; if so, to whom?	Did you ever know of any skylarking going on during the working hours amongst the men, such as throwing prisms or other articles at one another.	Was the house sufficiently lighted?	Were men anxious to work in the cam houses or not?	Is there anything connected with the cam house work which you would like to mention?
l the pins get hot, and any complaints about this. ock used to get very hot n, so that the hand could e on it.	No	Complained about charger hanging up.	No	Might have been better.	Don't know	No.
, could not bear hand on	No	To Foreman Ephgrave about pins running warm.	No	Yes; beautiful light..	Heard several say they would like to work there.	No.
r so warm that the hand ear it, the hot water used made them warm.	No	No	Never	Yes	Were anxious to work there; better pay.	Nothing.
f the way; the hot water shing made them warm. t, could not bear hand on	No	No	No	Yes	..	Was at drum house on night of explosion, on platform near shoe house. Heard a report, looked round and saw sparks issuing from the cam house, ran into shoe hole, changed shoes, took lamp out of cupboard, and ran towards cam house. Heard another explosion when in shoe hole, and a third when between No. 1 cam and press houses. With A. Carr, got Rudkin out of head water, and Clayden and Larman out of tail stream. Clayden said, "it was my machine which went first," Larman told me in hospital on Saturday after the accident that it was Clayden's machine which went first (No. 2.)
ed warm, never so warm d not bear my hand on mford has felt my pins and ere hot whilst I was wash- bout a week before the	Never had any fear	Only that I could not get the water to run very freely at times: to the foreman.	Never	Well lighted	Never heard any objection to the cam house work; those that have worked there prefer them to the moulding houses.	Nothing.
when washing out with er.	No	No	No	Yes	Never heard complaints.	I was working at the drum house. Biss and I were on our way to the drum house shoe room when we heard a report, and saw burning prisms flying about. We ran into the shoe room, took off shoes and put on boots, took the two electric lamps, and ran up as hard as we could to the cam house. A second explosion took place while we were changing our boots, and a third whilst we were running up, having got about to the press house. Carr's brother told him that the boat went last. Clayden told him as soon as he got him out of the water that it was his machine which "blew."
uld always bear my hand	No	No	No	Yes	Yes; rather than in some of the other houses.	Nothing.
so hot but that I could nds on them.	No	No	No	Yes	Yes; I would rather work there than in A, B, D, or G houses.	No.
hem get hot, only warm; s bear my hand on them.	Yes, when the charger would not come over, owing to powder getting under.	No	No	Yes	..	Improve means of cleaning out pins and plungers.
; could always bear the m.	No	No	No	Yes	Never heard any objections to work in the houses.	Would suggest holes in bottom crosshead in which pins work be made with a hole in the side, so as to squirt water into them.
ld always bear hand on	Thought the iron roller for counter-weight band over machine dangerous, as there was nothing to prevent its falling on the machine if it broke.	No	No	Yes	..	Pipes to bottom of machine, to take washing water and powder away. Steel parts of machine might be painted.
so warm; could not bear m.	No danger in them at all ..	No	No	Very good light ..	..	No.
o warm; could not bear em.	Could not see any danger in them.	No	No	Light very bad at times.	..	No. Cannot see where any improvement can be made in the machines.

Name.	Present employment?	When employed in cam house?	At which machine employed?	How did the machine work?	Did you have any difficulty with— (a) Pins?	(b) Plun
14. Hollingbury, George ..	Tankman, No. 5 moulding house.	From October, 1892, to January, 1893.	Boatman	Sometimes heard complaints about the chargers hanging up.	..	..
15. Knooler, Ernest ..	Blending house ..	From April to September, 1893, and a week previous to the accident.	No. 4 on 11th and 12th, No. 5 previous week at night.	No. 5 worked all right ..	Difficulty in getting water to run through pins at No. 4 on Monday. In the afternoon restarted the machine without getting the water to run. Left machine on Monday night in that condition. Tuesday, machine worked all right, and left it clean.	Top plungers got stopped, managed to with cane or water and upp
16. Lane, Walter	Millman..	For two or three years to about two years ago.	No. 2, mostly ..	Pretty fair	Sometimes when worn, difficult to get water to run. Never restarted working till water was got to run.	Top ones got Cleared with c pin, or remo soaked in hot w
17. Loder, Thomas ..	Chargeman, No. 1 moulding house.	From 1887 to 1893 ..	All	..	When pins were worn, there was a little difficulty in washing out, but always got the water to run before restarting.	A little difficulty plunger when hot, obstructio removed by u cane.
18. Mead, Harry	Drum house	For eight days before the accident (day shift that week).	..	Worked very bad the first four days; could not get water to run. Friday and Saturday went a bit better. Monday and Tuesday could not have worked better. Left them all right for Tuesday night.	Always got the water to run before restarting, in accordance with orders from Ephgrave and Bailey.	No .. ..
19. Mumford, Samuel ..	General	A week last year, and since the new water wheel was put in.	No. 4	All right till the new pins were put in	Yes, in getting water to go down on the Friday night and Monday, did not succeed in getting water to run through pins of Nos. 2 and 4. Left them so on Monday night. Tuesday morning they were better, and left them all right on Tuesday night.	No .. ..
20. Pearman, George ..	Main shifting room ..	For over two years to within two years ago.	All	Fairly	Could not get water to run down the pins freely sometimes. Never restarted working until had got water to run; had to unscrew pin from block and work it up and down until free when very bad.	Top plungers got sometimes; rem struction by me cane, or, if very water and old p moved and soake
21. Ponder, Joseph ..	Boatman, granulating house.	During August, 1893 ..	Boatman	Never heard any complaints ..	..	..
22. Robinson, Herbert ..	No. 2 granulating house.	For about 5½ years to three or four months ago.	All	..	Sometimes water would not run freely. Never restarted work without first getting water to run; this was the order, and was always carried out.	Top plungers somet clogged; cleared cane, and if this answer, plung taken off and s boiling water.
23. Saville, Charles ..	Millman..	For about two years to within three years ago.	Nos. 1 and 4, chiefly..	Charger used to work very bad, did not come over with certainty.	At times. Difficult to get water to run; always got it to run before restarting.	Top one used blocked; cleaned with cane or old removed and s hot water.
24. Skinner, Henry ..	Machinery	For about 18 months to night of explosion, when he was working No. 5 machine.	..	All right	A little difficult at times to get water to run. Never restarted until pins ran properly.	No .. ..
25. Steele, Henry	..	For about three weeks to day of accident (day shift).	No. 3	All right, very good machine..	Difficulty with last lot of pins to get water to run. Never restarted without getting water to run.	None .. ..
26. Taylor, George ..	No. 4 moulding house	From April to December, 1893.	Nos. 2 and 5.. ..	Very well	Yes, to get the water to run down in cleaning. No. 2 worse than No. 5. Always got the water to run before restarting the machine.	None .. ..
27. Wackett, Alfred ..	No. 3 dusting house ..	For three or four years to six months ago.	All	All worked well	Sometimes, when pins were difficult to get water to run. Never restarted working until water had been got to run. This was the order.	Sometimes top on clog. Remove soaked in hot w clean.
28 Wraighte, Cyril ..	No. 1 press house ..	For about a year four years ago.	All	Very bad. Chargers hung up..	Could not get water to run sometimes. Used to restart working without getting water to run.	Top plungers s got clogged, them and soaked

s?	Did you find the pins get hot, if so, so hot that you could not bear your hand on them?	Did you consider the machine dangerous; if so, in what way?	Did you ever complain about the machine; if so, to whom?	Did you ever know of any skylarking going on during the working hours amongst the men, such as throwing prisms or other articles at one another?	Was the house sufficiently lighted?	Were men anxious to work in the cam houses or not?	Is there anything connected with the cam house work which you would like to mention.
	..	..	..	No	Yes; quite enough to see to take powder in and out.	A great desire amongst the men to work in the cam houses.	Nothing; would willingly go to work there.
ometimes t always ar them ith hot rod.	Warm, but not so warm that I could not bear my hands on them.	No	No; thought it one of the safest houses in the factory.	Never	Yes	..	Nothing.
clogged. e or old ed and ter.	Sometimes warm, but not so warm that I could not bear my hands on them.	No	No	No	Yes	..	Nothing.
with top ins were easily ing the	No, could always bear the hand on them.	No	No	Never	Yes	Three parts of the men in the factory were always anxious to go there.	..
.. ..	Got warm, not so warm I could not bear my hand on them.	Wanted a lot of watching. Dangerous, as the charger was likely to hang up. Not much experience.	No	No	Yes	..	..
.. ..	No. 4 ran hot on Monday; could bear the hand on it. I have been in south end and felt pins on No. 2; they were very hot and could not bear hand on them for long. This was between bottom plunger and cross-bar to which pin is screwed.	Yes, I thought it dangerous because the water would not go through the pins properly.	Complained to foreman that water would not run down the pins in No. 4 machine.	Never saw prisms thrown about.	Yes	..	Objects to some machines working up for others which have been delayed from some cause or another, but has no real reasons for the objections.
stopped oved ob- ans of a oad, with n, or re- d.	Warm all over; could always bear hand on them.	No	No	No	Yes	Yes, rather at that time.	No.
	..	..	..	No	Yes, sufficient to take powder in and out.	..	..
imes got with a did not er was oaked in	They got warm, due to the hot water used for washing. Never got so hot in working that could not bear hand on them. Never heard of it.	Wanted great care, especially the charger. Did not consider the machine dangerous.	No	No	Yes	A good many used to ask for it.	Nothing.
to get it out l pin, or aked in	Middling warm, but never so hot I could not bear my hand on them. No part so hot.	No	Complained to engineer occasionally about charger and pins.	No	Yes, a nice light ..	Yes, I knew several..	No.
.. ..	Warm, but never so warm could not bear hand on them.	No	No	No	Yes	I believe they were. I have heard them ask to go there.	No.
.. ..	Got warm after washing out with water (boiling).	Not at all	No	No. Place always kept in good order, and clean platforms and all.	Yes	..	Tramcar between cam house and magazine. Carr told Nurse Jones this morning, and I heard him, that he saw sparks go in under the hood of the magazine.
.. ..	Only warm; could always bear my hand on them.	No; otherwise I should not have volunteered to go back to them the other day.	No	No	Yes	Heard no opinion as to machine being dangerous.	Nothing.
s would and ater till	Just a little warm	No	No	No	Yes	..	Nothing.
metimes emoved them.	Yes, got very warm; could not bear hand on them for long; also the bed.	Yes, because the charger sometimes came forward too sharply, cutting the prisms and sending them so that they hit the boards of the house. On one occasion in unscrewing screw securing bottom plunger, the steel plunger key-spanner slipped and struck side of the machine, causing sparks. This happened when at No. 1 machine. Reported it to Foreman S. Adams, to Mr. John Turnham, and Mr. Findlay. Machine had been washed out.	To Colonel Barker about the charger of No. 5 hanging up, and the manner in which the machines were working.	No	..	I believe a number of them were anxious.	Steel plunger-keys should not be used when there is powder in the house. Emery should not be used in cleaning the machines Shoeroom requires alteration to prevent grit getting from mat into house. Experienced men should be employed to work the cams.

APPENDIX VIII.

Accidents caused by Implements, &c.

Date of Accident.	Where Accident occurred.	Nature of Accident.
1854	Roslin	Man killed whilst chipping indurated powder from mill bed with a copper hammer.
16th June, 1870 ..	Lower Island Press-House, Waltham.	Five persons killed and four injured in an explosion caused by the use of a copper chisel, or spud, to separate the press plates.
22nd October, 1871 ..	Sedgwick	Some workmen were engaged in covering the roof of the corning house with roofing-felt, and for this purpose were driving a 3-inch nail into the roof, which was composed of sheet-iron. A spark fired the gunpowder in the house, and communicated to the press-house. Three killed, three injured.
30th March, 1872 ..	Tuckingmill	An iron "arm" of a machine in a fuze-spinning room fell on to the floor, and ignited some powder dust, which set fire to some fuze. Eight girls were suffocated.
17th April, 1872 ..	Ballincollig	Removing hard powder with a copper hammer, or scraper, from mill bed. One killed, one injured.
22nd December, 1872 ..	Melfort	A man chipped off incrustation of gunpowder in a mill with a metal tool, causing an explosion, which killed him.
24th July, 1874 ..	Gatebeck	A man killed whilst removing indurated powder from a mill bed.
3rd August, 1874 ..	Chilworth	A man killed whilst removing indurated powder from a mill bed.
12th October, 1875 ..	Factory 13. Westmoreland.	Two men killed whilst removing indurated powder from mill bed with a mallet. Attributed to grit.
15th October, 1875 ..	Factory 32. York.	A steel file fell in an earthenware bowl containing squib composition, and ignited it. Three killed and three injured.
12th May, 1876 ..	Factory 24. Cornwall.	Explosion (attributed to striking a wooden mallet on grit) occurred in the breaking-down house; communicated to expense magazine, press-house, and mill. Three killed.
14th October, 1876 ..	Factory 24. Cornwall.	An explosion occurred in the corning house, caused by removing indurated powder from metal rolls by a metal implement. Two killed.
9th March, 1877 ..	Factory 30. Cork.	One man killed whilst removing indurated powder from mill bed with a copper hammer.
2nd June, 1877.. ..	Factory 19. Westmoreland.	Millman trying to remove the "trod" by means of a wooden mallet without having taken the precaution to put on magazine overalls. One killed.
10th August, 1878 ..	Factory 15. Derby.	Gunpowder exploded in mill at Fernilee, through a hammer falling on iron lining of a runner while the mill was undergoing repairs. One killed, two injured.
27th March, 1879 ..	Factory 49. Middlesex.	Some powder dust, which had collected under the leather covering of one of the bolts, exploded while the leather was being removed. No one killed or injured.
11th April, 1879 ..	Factory 91. Nottingham.	An engineer using a steel chisel to ease part of a machine, to clean and overhaul it, struck a spark which ignited sweepings of powder. One injured.
21st April, 1879 ..	Cartridge Factory. Royal Laboratory.	A boy was killed by an explosion of some explosive on a table, which he is supposed to have struck with an iron spanner.
19th March, 1881 ..	Factory 40. Lancashire.	The gunpowder in the press-house exploded, possibly through a blow struck by a wooden hammer whilst breaking down mill cake, or in the operation of removing the pins of the press-box. Three killed and three injured.

ACCIDENTS caused by Implements, &c.—*continued.*

Date of Accident.	Where Accident occurred.	Nature of Accident.
21st July, 1881 ..	Factory 19. Westmoreland.	The gunpowder in the press-house exploded, possibly due to a blow on the press-box, given by one of the men removing cake from the press. Two killed.
11th April, 1883 ..	Factory 29. Cornwall.	During repairs to mill, a blow from a sledge hammer on curb ignited some incrusted powder. One injured.
24th April, 1883 ..	Factory 1. Yorkshire.	Slight explosion while removing indurated powder from curb of mill with phosphor-bronze pick. No one injured.
15th November, 1883 ..	Factory 11. Surrey.	Attempted removal of indurated powder by a copper spud. One injured.
9th July, 1885	Factory 2. Edinburgh.	Removing incrustations from mill with heavy metal spud. Two killed.
20th July, 1885 ..	Factory 21. Kent.	Mills were not working. The millman stated that the accident was his own fault, that he drew fire, but what was the exact act of imprudence that he committed did not transpire. One killed.
17th April, 1886 ..	Factory 11. Surrey.	Mill exploded at Chilworth, due to a wooden shovel being left on the bed. No one injured.
3rd June, 1886 ..	Factory 19. Westmoreland.	While changing mould block in cartridge press-house, and removing incrusted powder with a brass disc, the powder flashed. No one injured.
14th May, 1887 ..	Factory 22. Cornwall.	An old incorporating mill, which had been out of use for some time, was being taken down, a spark is supposed to have been caused by striking an iron bolt with an hammer. No one injured.
6th September, 1887 ..	Factory 23. Lancashire.	Two men were repairing Mill 25, using iron setters, or dogs, and a sledge hammer, and thus ignited some powder dust, which burned them fatally.
7th November, 1887 ..	Factory 29. Cornwall.	Press-house exploded, two killed; probably due to some percussion or friction in taking the press-box to pieces, &c.
16th February, 1888 ..	Factory 19. Westmoreland.	Millman was working at the "trod," the mill itself was free of powder except the "trod." The explosion fired some powder at the door. One injured.
18th March, 1888 ..	Factory 15. Derby.	Millman hit a portion of incrustation on curb with a brass hammer, it ignited and burned the man's face and hands. One injured.
27th April, 1889 ..	Factory 20. Argyll.	A worked charge had been removed, and the head mill keeper was engaged in preparing the mill for the reception of a green charge; while so engaged he employed a copper hammer incautiously, either in connection with the removal of some powder incrustations, or for other purposes. One killed.
22nd October, 1890 ..	Factory 2. Edinburgh.	An explosion occurred in the Kirkettle glazing house, due to improper repair of glazing reel, while containing gunpowder, with a steel wrench. Two killed.
6th May, 1891	Factory 18. Westmoreland.	The accident was caused by dragging the box (into which the worked charge is taken off) over the powder incrusted mill bed. Two injured.
11th September, 1891..	Factory 20. Argyll.	706 lb. of gunpowder exploded while a delta metal liner, or brush, was being forcibly removed from an iron die plate, used for compressing ".303" pellets, with a steel-ended punch. One killed.
10th November, 1891 ..	Factory 26. Brecon.	Millman was trying, in direct defiance to rules, to remove some powder incrustations from the bed with a copper paddle. One injured.
24th March, 1893 ..	Factory 15. Derby.	Engineer tapping the machinery with a brass hammer fired the clinker. Two injured.

The above list does not include cases of accidents from spindles and nuts on becoming fractured or detached.

APPENDIX IX.

Explosives Act, 1875.

Number of persons allowed in houses in which the pressing of gunpowder into pellets or prisms, whether for cannon or blasting, or small arms, is authorized to be carried on.

No.	Factory.	No. of persons.	No. of building.	Remarks.
1	Worsboro Dale	2	Cartridge press house	A.L. 298.
2	Roslin	4	Nos. 15 to 20	,, 397.
11	Chilworth	3	No. 12	,, 309.
15	Derby	2	Nos. 37, 38, 39	,, 458.
19	Gatebeck	6	No. 55	,, 130.
		6	,, 56	,, 232.
		3	,, 57	,, 539.
20	Kames	4	,, 93	,, 463.
21	Tunbridge	6	,, 97	,, 280.
23	Lowwood	6	,, 57	,, 219.
		3*	,, 22	,, 302.
		3*	,, 61	
		3*	,, 62	
24	Herodsfoot	4	Cartridge press house	,, 268.
26	Glyn-Neath	6	Pellet press house	,, 312.
		6	No. 70	,, 576.
33	Sedgwick	4†	,, 17	,, 113.
			,, 24	,, 248.
			,, 28–29	,, 597.
34	Elterwater	6‡	,, 27	,, 160.
		4	,, 39	,, 225.
37	Oare Works	4	,, 23	,, 51.
38	Marsh Works	2§	,, 110	,, 262.
40	Blackbeck	10‖	Pounding house	,, 32.
				,, 126.
				,, 146.
53	Dartford	6	No. 180	,, 414.
127	Dolgelly	2	,, 33	L. 72.
143	Midcalder	2	,, 17	A.L. 493.

* 3 with machinery, 6 without.
† 4 with machinery, 8 without.
‡ 6 with machinery, 10 without.
§ Total 12, but no more than 2 in any compartment.
‖ When licensed for 10 it was not at all contemplated to carry on making of the compressed cartridges. In other two houses since licensed for 10 it is expressly stipulated that no machinery is to be used. They do not, however, work to more than 6 persons.

APPENDIX X.

INSTANCES of Explosions in Cartridge Press Houses.

Date.	Particulars.	Killed.	Injured.
	AT EASTWOOD FACTORY.		
11th April, 1879	A man struck a spark with a steel chisel with which he was repairing the machinery, and caused an explosion.	..	1
	AT EASTWOOD FACTORY.		
About end of 1880.. ..	A piece chipped off press plunger and fired some grains of powder.	..	..
	AT EASTWOOD FACTORY.		
14th January, 1881 ..	Probably same cause. (*See* Special Report, No. XXXII.).	3	..
	DARTFORD GUNPOWDER FACTORY. (Messrs. Pigou, Wilks & Laurence, Limited.)		
23rd November, 1882 ..	In pressing a set of 40 prisms, one fired, igniting 20 others. The others escaped. Probable cause, friction.	..	..
	NEW SEDGWICK GUNPOWDER FACTORY.		
12th April, 1883	Probably, friction. No cause ascertained. (*See* Special Report, No. LII.)	3	..
	GATEBECK GUNPOWDER FACTORY.		
3rd June, 1886	Slight ignition of powder dust in changing mould block.	..	..
	AT FERNILEE FACTORY.		
22nd March, 1888.. ..	Explosion in cartridge press house, due to pressing machine being out of order. (*See* Special Report, No. LXXXIV.)	2	1

APPENDIX XI.

REPLIES from Gunpowder Makers in the United Kingdom, relative to Cam Presses, including a report on the use of these machines in Germany, by Mr. Heidemann.

Home Office Index No. of Factory.	Substance of reply.
40	Have never seen a cam machine.
143	Have no experience of cam machines.
33	Have never used cam machines, but after an accident in 1883 had cam and hydraulic presses under consideration, and decided in favour of latter.
11	Have four machines, of which two are identical with the Waltham Abbey ones. They have been in constant use since 1886, and the experience of them is entirely favourable; "of course it is essential that the machines are kept in proper condition."
37	Were the first to introduce the principle of the "cam" machines about 20 years ago, and have used that process continuously since, for compressed cartridges, for blasting purposes, and for prismatic military powder. Their experience is in favour of this form of manipulation, and they know of no special risk connected with its use.
34	Have no experience of cam machines; they have used hydraulic machines for about 12 years without any accidents.
24	Have no experience of cam machines; they use hydraulic power in preference.
	Have not any experience of cam cartridge pressing machines; in their opinion the working of such a machine would be attended with danger.
49	They forward the following extract from their manager's letter:—"In the year 1890 we erected two cam machines, with the requisite driving gear, at a cost of between 2,000*l.* and 3,000*l.*, for the moulding and pressing of S.B.C. and other brown prismatic powders. After starting the machines, and before we had taken out about a dozen pressings, we had trouble with the plungers and pins, the first bending and breaking, and the latter getting bent and jamming. We thought perhaps we might get over the difficulty, but before we had made 20 cases of S.B.C. we had to abandon the use of these machines from their extremely dangerous character, and lose our 2,500*l.*, as we have never worked them since this time. In fact, from the continual jamming and breaking of the plungers and pins, our men expressed so much anxiety over the danger in working these machines that we consulted our chief engineer, who agreed that the cam presses were dangerous, and the responsibility resting upon us was too great to insist upon the men working, as we were persuaded from the experience we had had that an accident sooner or later must follow."
53	Their manager's experience with cam presses has been for pellets only, but they add that "he is well acquainted with those used for prismatic powder, and that he has no hesitation in giving his opinion that from the quick action of these machines and the number of frictional parts there is a great deal more risk attending their use than with machines worked by hydraulic pressure. With the latter one pressing is performed in about five or six minutes, and the machine is completely under control. With the cam machines from 10 to 15 pressings can be turned out per minute, and as they work automatically they are not under immediate control, but if they were made to work slowly the risk would be much reduced and would hardly exceed that with hydraulic machines."
1	The machine in use at their mills for making compressed blasting cartridges has a "cam" action. It has worked very satisfactorily for 10 years, there has been no accident, and they are not aware of any special danger or risk attending the use of it.
2	Their experience is very limited, as they have only used such a machine for pressing cartridges for mining purposes, that only more experimental than otherwise. They gave up the machines, not as a matter of danger, but unsatisfactory working They are now erecting a large hydraulic machine to do the work.

REPORT by Mr. Heidemann on the use of Cam Presses in Germany.

[TRANSLATION.]

Cologne,
19th March, 1894.

Replying to the questions put by Sir Frederick Abel, and transmitted to me by Messrs. E. Kraftmeier & Co., respecting my experience with cam presses, I beg to state as follows:—

1. Sixteen Excenter (cam) presses have been in use since the year 1865 in our factories under my personal notice.

2. Besides several accidents to workmen, attended by a few contusions and bodily mutilations, which were the consequences of offences against the factory regulations and of carelessness on the part of the workmen in attending to the machines, the following more serious accidents causing loss of life have occurred with these presses during the period mentioned above:—

(*a.*) In 1878 an explosion took place at Hamm a/Sieg in an Excenter (cam) press during the manufacture of seven-hole black prismatic powder, by which two other presses were fired. The explosion was caused by a workman, notwithstanding the strictest prohibition, forcing a brass needle by hard blows into one of the channels of the upper bar while cleaning the same.

(*b.*) Another explosion took place in 1881 also at Hamm a/Sieg in an Excenter (cam) press during the manufacture of one-hole black prismatic powder. In this case the cause was the working of the press contrary to special instruction, after the breaking of a steel pin, without previously removing all the powder from the press.

(*c.*) In 1885 the loose remnants of powder were fired in an Excenter (cam) press at Dueneberg without doing any damage; this was caused by the carelessness of the workmen in removing a broken pin.

3. The velocity with which our presses are worked varies from 3 to 4 pressings a minute, the maximum in exceptional cases is 4½ pressings.

Besides the above-mentioned Excenter (cam) presses we have also in use at our factories three hydraulic presses for prisms with accumulators, which, as a rule, have 12 stamps or dies, and work at a velocity of 4½ pressings a minute. These presses allow of a larger production and of the use of higher pressure than the cam machines. They require a specially trained and thoroughly reliable staff of workmen. For the working of these presses, generally the following special factory rules are in force:—

(*a.*) During the working of the presses the quantity of powder in the house must be reduced to the smallest possible limit.

(*b.*) While the presses are working, every movement must be carefully watched, and they must never work without supervision.

(*c.*) When the least irregularity is noticed, the press must be stopped immediately, all powder must be removed, and then only may the cause be looked for; should any repairs or alterations of the press become necessary, the press itself, as also the floor within a radius of 3 meters, must be thoroughly wetted with water; during such repairs a watering-pot full of water must be kept handy.

(*d.*) The channels in the upper stamps as well as in the upper bar must always be kept clear, and for this purpose they must frequently be examined by inserting a wooden spill, which also serves to clean them.

(*e.*) The presses must be erected carefully, and must fit tightly and well into all beds and moving parts; to ensure safe and smooth movements, all friction must be avoided.

HEIDEMANN.

APPENDIX XII.

Copy of Forms used for Magazine Licences granted by the Home Office.

Form B.

No.

Magazine Licence.

Home Office Registry No.

Explosives.

Licensee's Name,

„ Calling,

„ Address,

Situation of the Magazine. { County, Parish, Place,

Explosives Act, 1875 (38 Vict. c. 17).

In pursuance of the power vested in me by the above-mentioned Act, I, the Right Hon. , one of Her Majesty's Principal Secretaries of State, grant and confirm this licence, authorising explosive to be kept at the magazine at the above-named situation, subject to the provisions of the said Act, and of any Orders in Council, Orders of a Secretary of State, bye-laws, regulations and rules made and to be made thereunder, and in force for the time being, and subject also to the terms hereunto annexed.

Home Office, Whitehall,

day of .

Form B* (3).

Home Office Registry No.

Terms of Licence.

The following are the terms annexed to the Licence No. , dated for a magazine for explosive:—

1. The site of the magazine shall be that shown on the plan signed by a Government Inspector, hereto attached, lettered A at the place marked

2. The distances to be maintained between the magazine and such buildings and works as are specified in the first schedule hereto shall be those set forth in the said schedule; and if at any time after the grant of this licence, by reason of the approach of any such buildings or works, the magazine ceases to be beyond the distances therein specified, this licence shall cease to authorise the use of the magazine for the keeping of explosive.

3. The mounds, buildings, and works in or connected with the magazine shall be those shown on the plan signed by a Government Inspector, hereto attached, lettered B, and their construction shall be as follows:—

The walls of the magazine shall be well and substantially built of good Portland cement concrete, containing not less than one part of best Portland cement, and five parts of clean, sharp, flinty gravel or ballast, with a proper proportion of sand. The roof shall be either of the same construction as is above directed for the walls, or shall be slated or tiled, and so secure internally by means of stout beams or cross pieces of

wood placed at close intervals, or by stout wire netting, iron bands, sheets of galvanized iron, or other suitable material, as in the opinion of a Government Inspector to afford reasonable security against unlawful entry.

The magazine shall be lined throughout with wood, and be provided with a close-joined wooden floor, and with two good and substantial doors securely affixed to the structure, and having hinges, as far as may be practicable, inaccessible from the exterior. The said doors shall open outwards, and the outermost door shall be of iron, or be faced externally with iron. Each of the said doors shall be fitted with not less than two strong locks, or with one lock throwing three bolts. The locks shall be of such a character as not to be easily picked or forced from the exterior.

The magazine shall be of the dimensions shown on the said Plan B, and the whole of the interior thereof (floor excepted) shall at all times be kept painted or varnished to the satisfaction of a Government Inspector.

If at any time it shall appear to the Secretary of State desirable that a wall or fence shall be erected about the magazine or any part thereof, there shall forthwith be erected and maintained such wall or fence as may be specified by the Secretary of State in his requisition for the erection of the same, and such wall or fence shall be deemed to be a part of the mounds, buildings, or works in or connected with the magazine.

4. No explosive shall be kept in the magazine other than

5. The quantity of explosive in the magazine shall not at any one time exceed

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Form B**(2).

Home Office
Registry No.

SCHEDULE.

Distances to be maintained between the magazine and other buildings and works :—

From every	Not less than
Room used in connection with the magazine, in pursuance of Section 46 of the Act.	
Workshop used in connection with the magazine, in pursuance of Section 47 of the Act.	
Mineral or private railway, whether worked by steam or otherwise ..	
Highway or public footpath	
Promenade or open place of resort for the public or for persons carrying on any trade or business	
Canal or navigable water	
Dock	
River wall or sea wall	
Pier or jetty	
Reservoir	
Room or workshop in connection with another magazine, store, or registered premises	
Any other room or workshop, or any shop	
Magazine for explosive	
Store ,, ...	
Furnace, kiln, or fire for the use of any boiler, engine, or machine, or for any manufacturing purposes	
Public railway	
Dwelling house, *with* the consent in writing of the occupier	
Dwelling house, *without* such consent	
Factory not belonging to Government	
Church or chapel	
University, college, or school	
Hospital or public institution	
Town hall or court of justice	
Covered market	
Theatre or building wherein persons are accustomed to assemble	
Public building in charge of the Commissioners of Her Majesty's Works and Public Buildings.	
Factory or magazine occupied by a Secretary of State, the Commissioners of the Admiralty, or other Department of the Government, with the consent, in writing, of the Secretary of State, Commissioners, or Department	
Do. without such consent	
Palace or house of residence of Her Majesty, Her Heirs, and Successors ..	

Provided that, in the case of any building or work above mentioned which is so screened from the magazine by the natural features of the ground, or by good and sufficient artificial mounds of earth as not to be visible from any part of such magazine, the distance assigned above as that to be observed between such building or work and the magazine may be reduced by one-half.

Provided also that, in the case of any building or work above mentioned which is so screened from the magazine by an intervening hill that, a line drawn from any part of such building or work to any part of such magazine would pass through such hill, the distance assigned by this schedule as that to be observed between such building and work and the magazine may be reduced by three-fourths, subject nevertheless to a notification in writing from a Government Inspector that, in his judgment the intervening hill, in respect of which such reduction is claimed, is not of a character to justify such reduction, whereupon this proviso authorising such reduction as aforesaid shall be deemed not to apply in respect of the said building or work.

APPENDIX XIII.

Copy of Forms used for Factory Licences granted by the Home Office.

Form A.

No.

Factory Licence.

Home Office Registry No.

Explosives.

Licencee's Name,

„ Calling,

„ Address,

Situation of the Factory. { County, Parish, Place,

Explosives Act, 1875 (38 Vict. c. 17).

In pursuance of the power vested in me by the above-mentioned Act, I, the Right Hon.
one of Her Majesty's Principal Secretaries of State, grant and confirm this licence, authorising explosive to be manufactured at the factory at the above-named situation, subject to the provisions of the said Act, and of any Orders in Council, Orders of a Secretary, byelaws, regulations, and rules made and to be made thereunder, and in force for the time being, and subject to the terms hereunto annexed.

Home Office, Whitehall,
day of

From A.

(*See* alternative Form in case of Firework Factories.)

Terms of Licence.

The following are the terms annexed to the Licence No. dated for a factory for

1. The site of the factory shall be that shown on the plan signed by a Government Inspector hereto attached,

2. The distances to be maintained between the factory, and such buildings and works as are specified in the schedule hereto, shall be those set forth in the said schedule; and if at any time after the grant of this licence, by reason of the approach of any such buildings or works, the factory ceases to be beyond the distances therein specified, this licence shall cease to authorise the use of the factory for the manufacture of explosives.

3. The mounds, buildings, and works on or connected with the factory shall be those shown on the aforesaid plan, and their construction shall be

4. No explosive shall be manufactured at the factory other than

5. The processes to be carried on in each part of the factory, and the place at which each such process is to be carried on, shall be

6. The limitations set forth in the schedule hereto, as to the description and amount of explosive and ingredients and articles liable to spontaneous ignition, or inflammable or otherwise dangerous, shall be duly observed.

7. The maximum number of persons to be employed in each building of the factory shall be

8. All the outer clothing of all persons engaged in any danger building shall be of woollen or other uninflammable material; and no pockets shall be worn by any person employed in any danger building.

9. Good and sufficient escape for all persons employed in any danger buildings; and every building in which explosive is present, or is liable so to be, shall be provided and maintained in connection with each such building.

Form A* (3).

(This Form is used in case of a Firework Factory.)

TERMS OF LICENCE.

The following are the terms annexed to the Licence No. dated for a factory for fireworks:—

1. The site of the factory shall be that shown on the plan signed by the Government Inspector hereto attached.

2. The distances to be maintained between the factory, and such buildings and works as are specified in the schedule hereto, shall be those set forth in the said schedule; and if at any time after the grant of this licence, by reason of the approach of any such buildings or works, the factory ceases to be beyond the distances therein specified, this licence shall cease to authorise the use of the factory for the manufacture of explosive.

3. The mounds, buildings, and works on or connected with the factory shall be those shown on the said site, on the aforesaid plan, and their construction shall be as specified in the schedule hereto. Each of the danger buildings shall be one storey only.

4. No explosive shall be manufactured at the factory other than fireworks as defined in an Order in Council classifying explosives made under the 106th Section of the said Act.

5. The processes to be carried on in each part of the factory, and the place at which each such process is to be carried on, shall be those specified in the schedule hereto.

6. The limitations set forth in the schedule hereto, as to the description and amount of explosive and ingredients and articles liable to spontaneous ignition, or inflammable or otherwise dangerous, shall be duly observed.

7. The maximum number of persons to be employed in each building of the factory shall be that stated in the schedule hereto, and when no limitation is expressed the number may be unlimited.

8. Each of the following shall be deemed a danger building:—

1. Every magazine.

2. Every building in which any one or more of the following operations is carried on, viz.:—

(*a.*) The mixing, or preparing, or packing of any explosive other than manufactured firework protected by a case.

(*b.*) The filling or charging of cases with explosive.

(*c.*) The breaking up or unmaking of any explosive.

3. Every building in which gunpowder or loose explosive composition, or firework unprotected by a case, is present or is liable so to be.

And every other building in the factory shall be exempt from being deemed a danger building.

9. All the outer clothing of all persons engaged in any danger buildings shall be of woollen or other uninflammable material.

10. Good and sufficient means of escape for all persons employed in every danger building and every building in which any explosive is present or is liable so to be, shall be provided and maintained in connection with each such building.

Form A†

SCHEDULE.

Distinguishing number, letter, or name of building, mound, or work on plan attached to licence.	Construction of building, mound, or work

Form A****

SCHEDULE.

Distinguishing number, letter or name of building, room or place on plan attached to licence.	Application of building, room, or place, or process to be carried on therein.	Explosive allowed or ingredients or articles liable to spontaneous ignition or inflammable, or otherwise dangerous, and limitation of quantity to be in each building, room, or place.	Limitation of number of work-people to be in each building, room, or place.

Form A**

SCHEDULE.

Distances to be maintained between each danger building (other than the factory magazines) of the factory, and other buildings and works outside the factory :—

From every	Not less than
Mineral or private railway, whether worked by steam or otherwise ..	
Highway or public footpath	
Promenade or open place of resort for the public or for persons carrying on any trade or business.	
Canal or navigable water	
Dock	
River wall or sea wall	
Pier or jetty	
Reservoir	
Room or workshop in connection with any magazine, store, or registered premises in pursuance of Section 46 or Section 47 of the Act.	
Any other room or workshop or any shop	
Magazine for explosive	
Store „	

From every	Not less than
Furnace, kiln, or fire for the use of any boiler, engine, or machine, or for any manufacturing purpose.	
Public railway	
Dwelling house, *with* the consent, in writing, of the occupier	
Dwelling house, *without* such consent..	
Factory not belonging to Government	
Church or chapel	
University, college, or school	
Hospital or public institution	
Town hall or court of justice	
Covered market	
Theatre or building wherein persons are accustomed to assemble ..	
Public building in charge of the Commissioners of Her Majesty's Works and Public Buildings.	
Factory or magazine occupied by a Secretary of State, the Commissioners of the Admiralty, or other Department of the Government, *with* the consent, in writing, of the Secretary of State, Commissioners, or Department.	
Ditto, *without* such consent	
Palace or house of residence of Her Majesty, Her Heirs, and Successors ..	

Form A***

SCHEDULE.

Distances to maintained between each factory, magazine of the factory, and other buildings and works outside the factory:—

From every	Not less than
Mineral or private railway, whether worked by steam or otherwise ..	
Highway or public footpath	
Promenade or open place of resort for the public or for persons carrying on any trade or business.	
Canal or navigable water	
Dock	
River wall or sea wall	
Pier or jetty	
Reservoir..	
Room or workshop in connection with any magazine, store, or registered premises in pursuance of Section 46 or Section 47 of the Act.	
Any other room or workshop, or any shop	
Magazine for explosive	
Store „	
Furnace, kiln, or fire for the use of any boiler, engine, or machine, or for any manufacturing purpose.	
Public railway	
Dwelling-house, *with* with the consent, in writing, of the occupier ..	
Ditto, *without* such consent	
Factory, not belonging to Government	
Church or chapel	
University, college, or school	
Hospital or public institution	
Town hall or court of justice	
Covered market	
Theatre or building wherein persons are accustomed to assemble.. ..	
Public building in charge of the Commissioners of Her Majesty's Works and Public Buildings.	
Factory or magazine occupied by a Secretary of State, the Commissioners of the Admiralty, or other Department of the Government, *with* the consent, in writing, of the Secretary of State, Commissioners, or Department.	
Ditto, *without* such consent	
Palace or house of residence of Her Majesty, Her Heirs, and Successors..	

APPENDIX XIV.

Handed to the Committee by Colonel A. Ford, one of Her Majesty's

TABLE SHOWING DISTANCES FROM PROTECTED WORKS FOR MA

In any case where the Protected Work is effectively screened from the Magazine or Danger Building either by the natural features of the ground or by good and substantial artificial mounds of earth or mine refu or mound, the distance from that Protected Work (except for quantities of 1,000 lb. and under) will be reduced one-half. Provided that when a natural hill so intervenes as to afford a degree of protection distance from Her Majesty's Palaces to be less than two miles.

The figures in *italics* are the distances to be observed when Gunpowder only is to be stored or other Explosives up to the equivalent of 5,000 lb. of Gunpo

Amount of explosive to be allowed in the Magazine or Danger Building	pounds	500	1,000	1 "ton" 2,000	3,000	2 "tons" 4,000	5,000	6,000	7,000	8,000	9,000	5 "tons" 10,000	11,000	12,000	13,000	14,000	15,000	16,000	17,000	18,000	19,000	10 "tons" 20,000	22,000	24,000	26,000	28,000	15 "tons" 30,000	32,000	34,000	36,000	38,000	20 "ton 40,0
Distances to be kept clear from—																																
Room used in connection with the magazine, in pursuance of Section 46 of the Act.. ..	yds.	50 *35*	50 *35*	50	51	52	52	53	53	54	54	55	55	56	56	57	57	58	58	59	59	60	61	62	63	64	65	66	67	68	69	7
Workshop used in connection with the magazine, in pursuance of Section 47 of the Act (*see* note (*b*))	,,	,,	75 *50*	100 *75*	101 *90*	102	104	105	106	108	109	110	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	138	14
Mineral or private railway, whether worked by steam or otherwise	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Highway or public footpath ..	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Promenade or open place of resort for the public or for persons carrying on any trade or business	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Canal or navigable water ..	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Dock	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
River wall or sea water.. ..	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Pier or jetty	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Reservoir	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Room or workshop in connection with another magazine, store, or registered premises	,,	100 *65*	150 *100*	200 *150*	200 *175*	200	200	200	200	200	200	200	205	210	215	220	225	230	235	240	245	250	265	280	295	310	325	340	355	370	385	40
Any other room or workshop or any shop	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Magazine for explosive.. .	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Store ,, ...	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Furnace, kiln, or fire for the use of any boiler, engine, or machine, or for any manufacturing purpose	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Public railway	,,	,,	,,	,,	210	215 *200*	225 *210*	235 *220*	240 *230*	250 *245*	255	265	270	280	285	290	300	305	310	315	325	330	345	355	370	380	395	410	420	435	445	46
Dwelling-house, *with* the consent, in writing, of the occupier	,,	50 *35*	75 *50*	100 *75*	110 *90*	120 *100*	130 *110*	140 *125*	145 *140*	155 *150*	165 *160*	175	180	190	200	205	215	220	230	235	245	250	265	280	295	310	325	340	355	370	385	40
Dwelling-house, *without* such consent	,,	100 *65*	150 *100*	200 *150*	240 *175*	280 *200*	320 *255*	365 *310*	405 *360*	445 *415*	485 *470*	525	560	590	625	655	690	720	750	785	815	850	920	990	1,060	1,130	1,200	1,265	1,330	1,395	1,460	1,5
Factory not belonging to Government	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Church or chapel	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
University, college, or school ..	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Hospital or public institution ..	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Town hall or court of justice ..	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Covered market..	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Theatre or building wherein persons are accustomed to assemble	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Public building in charge of the Commissioners of Her Majesty's Works and Public Buildings	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Factory or magazine occupied by a Secretary of State, the Commissioners of the Admiralty, or other Department of the Government, *with* the consent, in writing, of the Secretary of State, Commissioners, or Department ..	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Do. *without* such consent	,,	880 *585*	1,320 *880*	1,760 *1,320*	1,780 *1,540*	1,805 *1,760*	1,825 *1,790*	1,850 *1,820*	1,870 *1,850*	1,890 *1,880*	1,910 *1,905*	1,930	1,950	1,970	1,990	2,005	2,025	2,040	2,060	2,075	2,095	2,110	2,145	2,180	2,215	2,255	2,290	2,325	2,360	2,395	2,430	2,4
Palace or house of residence of Her Majesty, Her Heirs and Successors	miles	2	2	2	2 1/8	2 1/4	2 1/4	2 3/8	2 1/2	2 1/2	2 5/8	2 3/4	2 3/4	3	3	3	3 1/4	3 1/4	3 1/4	3 1/2	3 1/2	3 1/2	3 3/4	3 3/4	4	4 1/4	4 1/2	4 1/2	4 3/4	4 3/4	5	

NOTES.—(*a*) This table furnishes the basis on which applications for Licences will be considered, but is susceptible to modification under special circumstances.

(*b*.) Buildings and magazines *inside* a factory will be required to preserve the distances from each other specified in the second (Workshop) line of the table. The same rule will

(*c*.) Detonators may be kept in an annexe near to or adjoining a magazine under the following conditions:—

(1.) The amount of explosive contained in the detonators must not exceed 100 lb., reckoned in the proportion of not less than 2¼ lb. of explosive per 1,000 detonators. (T

(2.) The detonator annexe must be so constructed that not less than 2 feet of masonry and 3 feet of air-space shall intervene between any detonators in such annexe and t

spectors of Explosives.

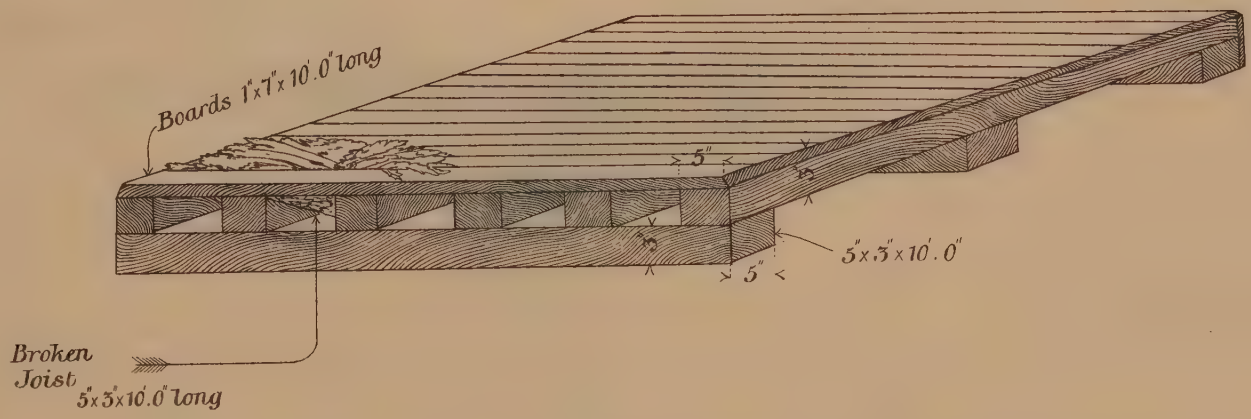
AZINES AND OTHER DANGER BUILDINGS.

e of such height that a line drawn from any part of the Magazine or Danger Building to any part of the Protected Work in question will pass through the intervening ground which in the opinion of a Government Inspector justifies a further reduction, the distance shown in the Table will be reduced to one-quarter. In no case, however, is the

der, every half pound of such other explosive (with certain exceptions) being reckoned as 1 lb. of Gunpowder.

..				25 "tons"					30 "tons"					35 "tons"					40 "tons"					45 "tons"					50 "tons"
0	42,000	44,000	46,000	48,000	50,000	52,000	54,000	56,000	58,000	60,000	62,000	64,000	66,000	68,000	70,000	72,000	74,000	76,000	78,000	80,000	82,000	84,000	86,000	88,000	90,000	92,000	94,000	96,000	98,000	100,000
	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200
	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

PLATFORM AT OUTER BUTTS, SHOWING DAMAGE DONE BY EXPERIMENT 2.



This sketch shows construction of Platform. The surface, however, was covered with Elephant's hide.

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APPENDIX XV.

Bursting of Barrels containing E.X.E. Grain.

A mixing tub, containing 90 lb. E.X.E. grain, was placed on centre of a wooden platform (construction described below) covered with leather hide.

The powder was loose and barrel unheaded. A No. 10 electric tube was placed on top of the powder and fired. Result—tub blown to pieces, explosion violent, no damage to platform, the bottom of the tub remaining on the platform close to its original position.

In the next experiment the arrangements were as above, but a small hole was bored near the bottom of the tub, and a small low tension primer inserted through the hole into the powder and fired. Result—a much more violent explosion than before, pieces of tub blown further and platform damaged. Over an area of about 3 feet by 4 feet, the boards completely broken, and baulk under the explosion, broken and driven into the ground.

E. BAINBRIDGE, *Colonel, R.A.,*
Superintendent Royal Laboratory.

1*st March*, 1894.

APPENDIX XVI.

Summary of Causes whence Accidents in the Manufacture of Gunpowder may proceed. Prepared by Colonel Majendie, C.B., Her Majesty's Chief Inspector of Explosives.

A—*Causes immediately connected with Tools or Machinery.*

1. Inherent defect in construction of machinery or implements.
2. Defective working of machine or tools, due to—
   - (1.) Fracture or distortion by wear or otherwise.
   - (2.) Clogging.
   - (3.) Other disturbance.
   - (4.) Improper application.
3. Fall of tool or portion of machinery.
4. Heated bearing.
5. Ignition caused in repairing or cleaning machinery.

B.—*Causes independent of Tools and Machinery.*

(A.) Accidental Causes.

6. Lightning.

7. Fire from external source.

(1.) Adjacent chimney.

(2.) Passing engine.

(3.) Other sources, *e.g.*:—

(*a.*) Men taking fire from watch-house or engine room on their clothes, on cooking utensils, or otherwise.

(*b.*) Fire from gluepot.

(*c.*) Concentration of sun's rays.

(*d.*) Lamps or fire.

(*e.*) Electric lighting or other apparatus.

8. Sparks from—

(1.) Articles of iron.

(2.) Articles of glazed earthenware.

9. Spontaneous ignition of cotton waste, &c.

10. Smoking—

(1.) In or near building.

(2.) Unextinguished pipe in workman's pocket.

11. Lucifer match—

(1.) From workman's pocket.

(2.) Left lying about.

12. Foreign substances, such as small stones, gritty particles, articles of metal, nuts, bolts, nails, &c., introduced—

(1.) On shoes or clothes.

(2.) On tools, machines, or cotton waste.

(3.) On barrels or barrows.

(4.) By being blown in.

(5.) In the ingredients—

(*a.*) If imperfectly sifted.

(*b.*) Contracted from walls and roofs of the buildings after sifting.

(*c.*) Derived from a machine or tool.

(*d.*) Contracted during conveyance.

(B.) Wilful Acts.

13. Matches, &c., wilfully introduced during the absence of workpeople.

14. Wilful ignition of powder-dust outside.

15. Wilful introduction into ingredients of foreign substance before the same were brought into the building.

16. Wilful act of workmen—

(1.) While in a state of insanity.

(2.) While in a state of intoxication.

(3.) With object of committing suicide.

17. Explosion of building by fuze or other means.

APPENDIX XVII.

List of Explosions and Fires at the Royal Gunpowder Factory, Waltham Abbey, from 16th June, 1870, to 13th December, 1893.

Date and hour.	House.	Nature of accident.	Injuries to workmen.	Damage to buildings.	Damage to plant.	Cause of accident.
16th June, 1870, 11.12 a.m.	Press house and granulating house, Lower Island.	Explosion of "press cake" while unloading press, the granulating house subsequently exploding.	Five men killed, ten injured.	Both buildings, also the machinery in them, completely destroyed.	Completely destroyed (in both houses).	Probably due to a particle of iron or grit in the "press cake," which was being separated, after pressing, by one of the deceased men (Simpson), who was using the regulation spud and mallet, when the explosion took place.
28th February, 1871, 8.30 p.m.	No. 2 mill, mill head ..	Explosion of "green charge" of gunpowder.	Mr. Edward Findlay, assistant master worker, and Mr. Seely of the Kame's Company, severely burnt.	No damage by the actual explosion (which was slight). Slight damage by fire.	None	Explosion took place immediately after the runners had been set in motion. Probable cause not stated.
17th July, 1871, 10 p.m.	No. 10 mill, Lower Island	Explosion of "mill charge" for pebble powder.	None	Very slight	Runners and mill bed slightly injured.	Not stated.
21st May, 1873, 12.15 p.m.	No. 9 mill, group "A" steam mills.	Explosion of "dust charge" of gunpowder.	None	Considerable, estimated cost of repair at 75*l.* to 100*l.*	Not serious	Could not be ascertained.
25th July, 1873, 9.30 p.m.	No. 6 mill, mill head ..	Explosion of "green charge" of pebble powder.	None	Very slight	None	Probable cause, a gunmetal bolt, which held the "plough" to the plough-arm, broke, and the runners "skidded" over it producing friction enough to cause explosion.
6th October, 1873, 9 p.m.	No. 1 mill, mill head ..	Mill "fired" while running on charcoal.	None	None	None	Mill had been under repair, and was run on charcoal previous to being put on powder. Cause of "firing" not discovered.
19th May, 1874, 1 a.m.	No. 1 mill, mill head ..	Explosion of picric powder, (57 per cent. saltpetre, 43 per cent. picrate of ammonia).	None	None	None	Must have been due to the accidental presence of some particles of iron or grit upon the bed of the mill.
15th July, 1876, 12.15 a.m.	Group "A" steam mills..	Explosion of a "green charge" of gunpowder.	None	A few panes of glass in skylight broken and canvas roof torn off in a few places.	None	No apparent cause assignable. Probably occurred through one of the runners coming in contact with the bed.

APPENDIX XVII.—*continued.*

Date and hour.	House.	Nature of accident.	Injuries to workmen.	Damage to buildings.	Damage to plant.	Cause of accident.
7th September, 1877, 6.10 a.m.	No. 6 mill, mill head	Explosion of 60 lb. "rework charge" of L.G. powder.	None	South end blown completely away, north end found blown out, windows broken. No. 3 mill slight damage.	South end mill bed cracked.	Impossible to assign exact cause. Most probably caused by the "licking up" of the charge, *i.e.*, the runners "licking up" the charge in one of their revolutions and coming on the bare bed the next revolution.
4th May, 1878, 9.45 a.m.	Saltpetre extracting house	Fire	Barnard severely burnt, died 7th May, 1878, at 1.45.	Slight by fire	None	Barnard removing hard refuse from powder-pot, with iron spud, when cleaning out house for repairs; a copper spud should have been used.
16th July, 1879, 7.30 p.m.	Sulphur refinery	Fire	None	Portion of roof burnt	None	Over-heating of the woodwork in the roof in the vicinity of the chimney or iron tube, leading from the iron funnel suspended over the refining-pot to carry away the fumes.
7th July, 1882, 9.50 p.m.	Group "B" mills, Lower Island.	Explosion of a "green charge" of gunpowder.	None	Roof partially injured	None	Possibly due to a small piece of grit being accidentally present in the "green charge."
22nd August, 1890, 6.35 a.m.	No. 1 breaking-down house, mill head stream.	Explosion in "breaking down" R.F.G.^{2} mill cake.	Napthen and Maynard killed, A. Wilson injured.	House demolished	Breaking-down machine destroyed.	No cause could be assigned.
4th November, 1890, 8.25 p.m.	Group "C" steam mills, No. 15A mill.	Explosion of an 80 lb. blank L.G. "dust charge."	None	Shutters, doors and woodwork of roof blown away and other damage to it, and to 13A, 14B and 15B group of mills.	Mill bed cracked and crown wheel broken and other slight damage.	No cause could be assigned.
4th May, 1891, 6.7 a.m.	Group "E" steam mills..	Firing of "green charge" of small arm G.F. powder.	None	None	None	No cause could be assigned.
11th March, 1892, 10.50 p.m.	Group "G" steam mills, No. 27 mill.	Explosion of a 60 lb. small arm pellet powder "green charge."	None	Roof destroyed and other damage to it, and adjoining mills of "G" and "D."	Bed plate cracked and other slight damage.	No conclusive proof of cause.
13th December, 1893, 2.35 a.m.	No. 2 cam house, Lower Island.	Explosion of "E.X.E." grain and prisms.	One man killed, eight men died subsequently, one badly injured.	Completely destroyed by fire.	Hoppers of four machines destroyed.	No cause could be assigned.

21st March, 1894.

W. MCCLINTOCK, *Colonel*,
Superintendent Royal Gunpowder Factory.

APPENDIX XVIII.

EXTRACTED from the Appendix to the Report from the Select Committee of the House of Commons on Explosive Substances, 1874. (Appendix, No. 19, pages 366 and 367.)

PAPER HANDED IN BY MAJOR MAJENDIE.

LIST of Articles found at various times in the Gunpowder Works at Waltham Abbey, or in Barrels of Gunpowder at the Government Establishments at Purfleet and Woolwich, and at present deposited at Waltham Abbey.

The following list shows that, even with the strictest precautions and the most scrupulous vigilance, there is no absolute security that all risks which attend the storage, manufacture, and manipulation of powder can be invariably estimated. It is, therefore, imprudent to assume that even those buildings which (from their freedom from complicated or dangerous machinery) are comparatively free from the more serious manufacturing risks—such as magazines, and the packing rooms, dusting and glazing houses of gunpowder factories—are wholly free from the risk of explosion. To the following list may be added a case which occurred a few years ago, when a lucifer match was found, with some percussion caps, in a barrel of Government gunpowder at the Royal Cartridge Factory, Woolwich. This barrel of powder had come from a Government magazine.

In another case a detonating tube was found by Major Keates, R.A., in a barrel of gunpowder at the Government establishment at Bull Point.

D. MAJENDIE, *Major, R.A.*,
Her Majesty's Inspector of Gunpowder Works.

List of Articles in the Cupboard.

1. Iron nut, $1\frac{1}{2}$ inches square by $\frac{1}{2}$ inch thick. Found in the charcoal mill while grinding dogwood. By it three cogs were broken out of the pit wheel. 23rd April, 1857.

2. Piece of beech wood, $5\frac{1}{2}$ inches long, $2\frac{1}{2}$ inches wide, $\frac{7}{8}$ inch thick. Found on the screens of No. 2 granulating machine, after passing the top pair of rollers. 7th October, 1859.

3. Stone, $1\frac{1}{4}$ inches by $1\frac{3}{4}$ inches thick. Found on top plates while loading No. 1 press. 20th February, 1860.

4. Stone, $\frac{3}{8}$ inch square. Found in press cake at No. 1 press when unloading. March, 1860.

5. Iron fragments. Found on bed of steam mill D, when vertical shaft broke. 17th July, 1860.

6. Iron key of cupboard. Found in the chucks from the granulating machine, No. 1, while making Enfield rifle powder. 18th June, 1861.

7. Knife blades, &c. Found in charcoal mill while grinding. 20th September, 1861.

8. Iron bolt, $1\frac{3}{4}$ inches at head, $4\frac{1}{2}$ inches long. Found on the south end of No. 11 mill, L.J. The runners had passed over it. 7th November, 1861.

9. Copper knob-cover of lubricator, $2\frac{1}{4}$ inches diameter. Taken from No. 1 granulating machine, after having passed through the top pair of rollers. January, 1864.

10. Pieces of iron, $3\frac{1}{8}$ inches by $1\frac{1}{4}$ inches, $\frac{1}{8}$ inch thick. Found in the press plates of No. 2 press while loading the press. 8th August, 1864.

11. Coper bolt, $1\frac{1}{4}$ inches diameter head, $3\frac{1}{2}$ inches long. Found on the bed at the north end of No. 4 mill. It had been brought there in a dust charge, as the washer and part of the nut were found in the granulating machine next day. 12th May, 1865.

12. Copper bolt, $\frac{7}{8}$ inch at head, $2\frac{1}{2}$ inches long. Found under the curb of No. 6 mill. This bolt belonged to a reel at No. 1 dusting house, and was sent from there in a dust charge. Caused the explosion of the north end of the mill, and also the north end of No. 3 mill, on the opposite side of Mill Head; both mills on dust charges of R.L.G. 13th June, 1866.

13. Copper bolt to fasten screens to frame, $1\frac{1}{2}$ inches at top, $2\frac{1}{4}$ inches long. Shaken out of the lower screens of No. 2 granulating machine, having been taken up with the chucks, and passed all through the machine. 13th December, 1866.

14. Piece of iron, $2\frac{1}{4}$ inches long, $\frac{5}{8}$ inch diameter. Found in a bundle of dogwood at the cylinder house. 19th May, 1868.

15. Pieces of iron, from 5 inches to 3 inches long, $\frac{1}{2}$ inch diameter. Found while picking dogwood charcoal at different times. 15th December, 1868.

16. Grit. Found in new magazine, having fallen from joints of brickwork. 16th July, 1869.

17. Copper bolt to fasten plough, 3 inches long. Found on the bed of No. 12 mill, north end, while the millman was uncharging, the runners having passed over it several times without causing explosion. 31st August, 1869.

18. Steel needle. Found in L.G. powder received from Upnor, while examining at Purfleet. 22nd November, 1869.

19. An iron rivet head. Found in charcoal mill while grinding common charcoal. 13th April, 1870.

20. An iron rivet head. Found while picking charcoal. April, 1870.

21. Small pieces of iron. Found in cotton waste supplied for cleaning machinery in powder and other houses. September, 1870.

22. Small pieces of iron and iron wire. Found in cotton waste supplied for cleaning machinery in powder and other houses. October, 1870.

23. Bullets and caps. Found in R.F.G. powder, sent from Purfleet for redusting March, 1871.

24. Copper tack. Found in a barrel of blank R.F.G. powder while being sifted in the Royal Laboratory, Woolwich. 15th August, 1871.

25. Copper nails and piece of copper hoop. Found in a barrel of returned Service L.G. powder sent to Woolwich for small-arm ammunition. 1871.

26. Clay pipe. Found while picking dogwood charcoal; it had been enclosed in a bundle of dogwood, and was burnt with it. 5th July, 1872.

27. Small stones. Found at Woolwich, in a barrel of powder, marked (Powder, L.G., 100, redusted, July, 1872). 13th August, 1872.

28. Copper nail, 2 inches long. Found in a piece of picric mill cake, on breaking it up for granulating. 19th December, 1872.

29. Stones. Found at No. 1 dusting house, while sifting F.G. powder for redusting. 20th December, 1872.

30. Stones. Found at No. 1 dusting house, while sifting F.G. powder for redusting. 24th December, 1872.

31. Copper nail and caked powder. Found at Royal Laboratory in a barrel of L.G. powder, marked from examination, 1872. February, 1873.

32. Bullets, cartridges, caps, &c. Found in powder received from Purfleet for redusting. February, 1873.

33. Bullets. Found in F.G. powder, received from Purfleet for redusting. February, 1873.

34. Iron bolt, $4\frac{3}{4}$ inches long, $\frac{1}{2}$ inch in diameter. Found in a barrel of R.L.G. powder, by Captain Majendie, R.A.

35. Refuse, hair, &c. Found in powder at Purfleet, returned for examination.

36. Copper chisel, 3 drams measure, iron stones, &c. Found in powder sent to Waltham Abbey, for redusting.

37. Pieces of iron. Found while grinding charcoal.

38. Copper bolt, $3\frac{1}{2}$ inches long, 1 inch diameter of head, from the outside plough of No. 6 mill. Found in the bed after causing the explosion of south end of mine. 25th July, 1873.

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REPORT OF THE COMMITTEE

APPOINTED TO ENQUIRE INTO THE

EXPLOSION OF THE 7TH MAY, 1894,

AT THE

NITRO-GLYCERINE FACTORY,

WALTHAM ABBEY,

TOGETHER WITH

MINUTES OF EVIDENCE AND APPENDICES.

Presented to both Houses of Parliament by Command of Her Majesty.

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NAMES OF MEMBERS OF THE COMMITTEE.

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Lord SANDHURST, Parliamentary Under Secretary of State for War.

Members.

Sir FREDERICK ABEL, Bart., F.R.S., &c.

Colonel V. D. MAJENDIE, C.B., Her Majesty's Chief Inspector of Explosives.

Major-General F. T. LLOYD, C.B., R.A., Deputy Adjutant-General, Royal Artillery.

Mr. R. H. BRADE, *Secretary.*

REFERENCE.

(Copy of minute addressed to Lord Sandhurst by the Secretary of State, 9th May, 1894.)

"I shall be glad if your Committee, which lately enquired into the circumstances of the gunpowder explosion at Waltham, will now proceed to bring within your enquiry the explosion in the nitro-glycerine factory on the 7th May.

74
Gen. No.
3652

"H. C.-B."

"*9th May*, 1894."

Enquiry into the Explosion of 7th May, 1894, at the Nitro-glycerine Factory, Waltham Abbey.

REPORT.

Secretary of State,

Reference. On the 7th May, 1894, an accident occurred at the Nitro-glycerine Factory, Waltham Abbey, and on the 9th of that month you requested the Committee, which had previously been appointed to investigate, and had recently reported upon, the circumstances, &c., of the accident of the 13th December, 1893, to proceed to bring within their enquiry the explosion in the nitro-glycerine factory on the 7th May.

Proceedings of the Committee. The Committee have visited the scene of the accident, and have taken the evidence of a number of witnesses who were in the immediate vicinity at the time, and of members of the managing and administrative staff of the factory. They have also consulted Drs. Dupré and Kellner, and Sir Benjamin Baker, and have obtained information relating to certain details of the manufacture of nitro-glycerine in private factories, from Mr. G. McRoberts, Mr. O. Guttmann and Mr. C. O. Lundholm.

They now beg to present their report.

I.—Circumstances of the Accident.

Explosions in the washing house and nitro-glycerine store. The explosion took place at 4.8 p.m. on Monday, 7th May, 1894, in that part of the factory on Quinton Hill, Waltham Abbey, where the manufacture of nitro-glycerine (for cordite) is carried on. There were in fact two explosions, viz., one in the building described as "washing house" in the plan of the Quinton Hill Factory hereto annexed, and one in the building situated 61 yards to the south of the washing house, and described as "nitro-glycerine store." The two explosions were so nearly simultaneous as to have led many persons who were near the spot to believe that only one had actually occurred, whilst those witnesses who heard the two testify to their having succeeded each other at an almost inappreciably short interval. This point is one which will be found to possess some importance in connection with the examination into the possible cause of the double or communicated explosion, and it is, in the judgment of the Committee, intimately related to the subject of the reconstruction of these buildings, and of their situation and protection in the future.

Appendix I.

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Construction of exploded buildings. As regards the two exploded buildings, it may be stated in general terms, that they were wooden structures, with tarred felt roofs, each one being surrounded on all sides by high brick-revetted earth traverses as shown in the plans hereto annexed.

Appendices II. and III.

Operations in progress in the exploded buildings. In the washing house were carried out (by arrangements to be hereafter more particularly described) the final washing and purification (to test) of the nitro-glycerine, and the filtration of the purified material. The purified and filtered nitro-glycerine was run down a "V"-shaped leaden gutter in a wooden tunnel to the second of the exploded houses, shown as the "nitro-glycerine store," on the plan, and here the nitro-glycerine was stored, and afterwards weighed out into charges, which were poured on to weighed charges of guncotton preparatory to removal for incorporation.

Appendix I.

Amount of nitro-glycerine present in the exploded buildings.

The quantity of nitro-glycerine present in the washing house at the time of the explosion was about 1,500 lb.; in the nitro-glycerine store there was about 2,200 lb. The total quantity which exploded was thus about 3,700 lb., or not far short of 2 tons.* No explosion occurred in any other houses of the factory, distant from 37 to 462 yards. 118, 462 Appendix VI.

Disturbance of guncotton in process of manufacture.

The falling glass and débris from the roofs, &c., cracked or broke a number of the earthenware nitrating pots in the neighbouring guncotton factory, and admitted the water to the guncotton in process of digestion in the acids, thereby causing the same to fume off.

Escape of the charge of nitro-glycerine in the nitrating house.

In the nitro-glycerine factory, a quantity of this liquid, in process of separation (from the acids), in No. 2 nitrating house, had a narrow escape, as the building was considerably injured, and débris fell into the separating tank, none of which, fortunately, appears to have been wood or of a carbonaceous character (being chiefly or entirely glass); otherwise, this charge could hardly have escaped explosion. Mr. William Thomson, one of the chemists at the works, was managing the nitro-glycerine factory in the temporary absence of Mr. James Thomson; he was about 300 yards away in a building in the cordite factory, at the time of the explosion, and sustained some injury, but, with great presence of mind, he immediately proceeded, assisted by others, to let the contents of the separating tank down into the drowning tank (provided for emergency), and there washed the nitro-glycerine until all danger of explosion was removed. Through the promptitude and skill of Mr. William Thomson a further explosion was probably averted. 155, 418

Explosion, of nitro-glycerine only, and not of cordite.

As this accident has been more than once described in the public press and elsewhere as a "cordite explosion," and has indeed been referred to as illustrative of the great risk attending the manufacture of cordite, and even as establishing to some extent the unsuitability of that material for service-purposes, the Committee think it desirable to point out, most emphatically, that it was not a cordite explosion at all. It was an explosion of nitro-glycerine pure and simple, and an explosion which might equally have occurred whatever the ultimate destination of the nitro-glycerine; whether it was intended to be used in the manufacture of dynamite, blasting gelatine, or any one of the numerous explosives into which nitro-glycerine enters as a constituent. It would be as unreasonable to set down to the discredit of fireworks an explosion of gunpowder which was being manufactured with a view to its being ultimately employed elsewhere in making squibs or crackers, as it is to debit cordite with an explosion of nitro-glycerine, merely because such nitro-glycerine was destined, when its manufacture was completed, to be elsewhere worked up into cordite. Percussion caps have not hitherto acquired a reputation of being unsafe or unreliable articles, because accidents have happened in the manufacture of the fulminate of mercury used in their preparation, or even in the mixing of the detonating composition with which they are filled.

In the present case it happens, as a matter of fact, that the explosion, so far from justifying doubts or suspicions, furnished remarkable and most instructive testimony as to the relative safety of cordite.

Freedom of a large quantity of cordite from explosion or ignition.

Although the cordite factory, which, it should be noted, is distinct from the nitro-glycerine factory (although in the judgment of the Committee injudiciously near to the same), and under separate management, was situated only from about 60 to 300 yards from the explosion and was in full work at the time, Appendix VI. and although the buildings were greatly shattered and many persons within them sustained injury from falling or projected débris, not a particle of cordite even took fire, still less exploded. Even more striking testimony to the relative safety of this material, as compared, for example, with black gunpowder or even with guncotton, is afforded by the fact that a building (known as guncotton stove, No. 1) distant only 85 yards, which was used for drying cordite, and which contained at the time 3,000 lb. of that material in process of drying by hot air, although almost completely broken up and crushed in by the explosion, was not exploded, none of the cordite being even ignited or in any way injured, except by the impingement of falling débris. The Committee therefore think it their duty to make the fact generally known, that this accident, so far from impairing confidence in cordite or of presenting considerations to its possible disadvantage, has afforded powerful testimony to the comparative inertness of the material. 570–4 718–21

* In measuring explosives, 2,000 lb. is reckoned as a ton.

The risks attending the manufacture of nitro-glycerine are generally known and well recognized, as also are those which attend the manufacture of guncotton (at any rate when it has reached the dry stage), and it was never supposed that these risks would disappear, any more than it would be reasonable to believe that they would be enhanced, when the nitro-glycerine or dry guncotton happened to be destined for conversion into cordite. In the present case there occurred an explosion of nitro-glycerine and an ignition of guncotton, during the processes of their manufacture; but there was no explosion nor even ignition of these substances, either when in process of being combined, or when actually combined, to form cordite, although the conditions were in some respects (and especially in the case of the cordite which was being dried in "No. 1 guncotton stove"), *primâ facie* so favourable to ignition or explosion that, with the majority of explosives, one result or other would almost certainly have ensued.

Origin of explosion.

See, for example, Pegram's evidence, 220–229.

The two explosions occurred almost simultaneously, as has been stated, but the Committee have come to the confident conclusion (notwithstanding some conflict of evidence on the subject), for reasons which they will hereafter more fully explain, that the originating explosion occurred in the washing house, and that the explosion of the nitro-glycerine in the tanks was produced by the breaking up and crushing in of the store house and by the action of its falling débris, due to the wave of pressure and the subsequent exhaustion established by the washing-house explosion.

In view of this conclusion, it becomes necessary to consider carefully the nature of the operations carried on in the two houses, and to ascertain, so far as may be practicable, what work was actually in progress at the time.

Details of the operation in progress at the washing house.

The series of operations carried out in the washing-house consisted of—

1. The final washing and purification (to test) of nitro-glycerine transferred by gravitation from the separating and pre-washing tanks, in the nitrating houses;
2. The re-washing and re-purification of nitro-glycerine collected from the wash-water in the wash-water house;
3. The sampling of the purified nitro-glycerine for testing; and
4. The filtration of the same, preparatory to its being run into the store.

Washing tanks.

14, 62
Appendix XI.

The appliances for washing are practically (except as regards the dimensions of the tanks) the same as those which have been in use at the Ardeer Factory of Nobel's Explosives Company (Limited), for at least seven years; they consist of two circular leaden tanks, each 39 inches in diameter, and 35 inches deep, and furnished with earthenware taps at the bottom, one for running off the washed nitro-glycerine, and the other for running off the waters used in washing.

Water used for washing.

Appendix XI.

The wash-water used consisted of a succession of warm soda-solutions, which floated on the top of the nitro-glycerine (when the contents of the tanks were at rest), and were ultimately drawn off by means of a leaden skimmer, which was suspended from the ceiling by a pulley, and had attached to its bottom an indiarubber pipe leading to the tap at the bottom of the tank; the washing was effected by powerful air-agitation, whereby the two liquids were maintained in thorough admixture, the air being introduced through a lead pipe, the lower arm of which rested on the bottom of the tank. The quantity of nitro-glycerine washed in one tank at a time was one charge from a nitrating house, viz., about 750 lb., *plus* such small quantity as might be brought from the wash-water house, for re-washing and re-filtration.

Temperatures of wash-waters.

61, 82

The soda-solution employed in the washing process was not allowed to exceed a temperature of 50 degrees Centigrade (122 degrees Fahrenheit) when run into the tanks,* and each batch of nitro-glycerine was subjected to four washings, the durations of which were, respectively, 15 minutes, 15 minutes, 45 minutes, and 15 minutes, the last washing being continued longer, if necessary.

Test of purification.

The chemist in charge tested the chemical sufficiency of purification of

* No. 1 Rule for the washing house lays down that the temperature in this tank must not exceed 50 degrees Centigrade.

the nitro-glycerine by means of litmus paper before it was filtered through salt, as shown in detail in Appendix XVI., after which it was run down to the nitro-glycerine store.

Stage reached in the work of the washing house at time of explosion.

It is, in the judgment of the Committee, not difficult (from the evidence of James Strange, who left the house only 8 or 10 minutes before the explosion, where he was succeeded by the deceased man Frost) to arrive at a fairly reliable conclusion as to the work which was actually in progress at the time of the accident. Two charges of nitro-glycerine had been washed that day and removed to the store; at the time of the explosion, two more charges (each of about 750 lb.) were in process of being washed, and of these, Strange estimates that the third charge would have reached the stage when the third washing was complete, the third wash-water being probably in process of removal; the fourth charge was most probably undergoing its second washing. When Strange left the house, no other nitro-glycerine was present there besides the two partially washed charges in the tanks. As will be hereafter explained, it is almost certain that Frost was in the house working at or near the tanks, and that the other three men who were killed were just outside the house on the west side, near the door. 116, 251–4 251–4 282–3

Details of the use of the nitro-glycerine store.

The main use of the building known as "nitro-glycerine-store," was for the storage, in two large leaden tanks (each capable of containing about 2,200 lb.), of the successive charges of purified nitro-glycerine, transferred by gravitation from the washing house. But a quasi-manufacturing operation was also carried on therein, which consisted in the weighing out of charges of nitro-glycerine from the store tanks (from which it was drawn through earthenware taps), and the pouring of these into charges of guncotton preparatory to the removal of the two ingredients to the mixing house for preliminary incorporation. No guncotton was kept in the house; the charges were brought there, in covered vessels, only to receive the nitro-glycerine, and were then immediately removed. As a matter of fact, however, no such operation was in progress at the time of the accident. The house was then being applied exclusively to its first or principal use, as a store for purified nitro-glycerine, of which a quantity, estimated at 2,200 lb., was present. No person was in or near the house, nor had anyone been there for about $\frac{1}{4}$ hour previously; and the house itself, and the door through the traverse leading to the same, were both locked. 335–8 340 340–1

General conclusion as to the conditions of the exploded buildings at the time of the explosion.

The Committee arrive therefore at the following general conclusions as to the state of things when, about 4.8 p.m., the whole factory and neighbourhood were alarmed by a tremendous explosion:—Of the two exploded houses, one (the washing house) was in active work, and contained about 1,500 lb. of nitro-glycerine in process of washing, that process being already considerably advanced; there were four persons in and about the building, all of whom were killed; the other house (the nitro-glycerine store) was not in work, and was locked up; the only explosive present therein was 2,200 lb. of purified nitro-glycerine, and no one was in or about the house.

II.—Results of the Accident.

A.—*Injury to men.*

The explosion unfortunately proved fatal to four persons, while about 20 other persons sustained personal injuries (generally of a slight character).

The four persons who were killed were William Bennie, principal chemist of the nitro-glycerine factory, under Mr. James Thomson; George Suckling, foreman in the nitro-glycerine factory, under Mr. Bennie; William Ingram, foreman plumber; George Frost, a danger-house man. From the position and condition of the remains of these unfortunate victims of the accident, it has been, and as the Committee think, reasonably, assumed that when the explosion occurred, the three first-named were just outside the house near the door on the west side; Ingram probably being at the foot of the steps inside the traverse; while Frost was almost certainly in the house, and most probably at one of the washing tanks (which would have been his natural place while washing was going on). The injuries to the persons not fatally hurt, were, 39 42 45 47–9 49, 394–7, 414–5

540 in some instances, due to the projection of the bricks with which the traverses were revetted, and this circumstance suggests the expediency of some modification of the construction to be adopted for future traverses. The other injuries were inflicted by falling glass or other débris.

B.—*Structural and other Damage.*

Apart from the complete destruction of the two exploded buildings and of the traverses surrounding them, very considerable and extensive damage was done to other buildings in, and to some outside, the factory, while minor structural damage was effected in some instances up to 900 yards, and windows were broken to a distance of over 2 miles.

The details of the damage done and of the distances at which effected, are given in Appendix VI., furnished by the Superintendent of the Factory, who, it will be seen, in summarizing the damage estimates the results broadly as follows:—

Serious structural damage (such as destruction of substantial walls and masonry buildings) ..	95 yds.
Minor structural damage (such as injury to unsubstantial buildings and structures, breaking of window-sashes, doors, &c.)	900 yds.
Distance to which heavy débris was projected ..	700 yds.
Distance to which lighter débris was projected or carried..	with the wind, 650 yds., against the wind, 120 yds.
Windows broken and plaster shaken..	S.E. direction 2 miles $3\frac{1}{2}$ furlongs. E.N.E. „ $1\frac{3}{4}$ „ N.W. „ $1\frac{1}{8}$ „

III.—Probable Cause of the Accident.

Point of origin of explosion.

The Committee felt that, before attempting to arrive at a conclusion as to the probable cause of the accident, it was essential to decide which of the two houses, the washing house or the store, exploded first.

Obviously, if it could be established beyond all reasonable doubt that the explosion originated in the store, it would be unnecessary to examine the various possible causes of the accident which might suggest themselves as connected with the washing house and the processes carried on therein, and the enquiry would thus be very considerably simplified in the sense of being narrowly limited in its scope.

Evidence as to there having been two explosions.

The Committee have already adverted to the fact that it has not been easy to obtain any positive evidence from ear- and eye-witnesses as to the occurrence of two distinct and separate explosions. Indeed the majority of the witnesses examined by the Committee, or questioned informally by individual members, speak to one explosion only, or to a loud rumbling, culminating in a violent explosion, but not accentuated at its commencement by any defined report. Mr. William Thomson's description of what he heard
149, 150–2 probably covers what the majority say they heard. "At first there was a rumbling, something like the noise made by a train coming into a station, then there was a terrific noise." *Q.*—"The noise was not marked in its commencement by an explosion?" *A.*—"No." *Q.*—"So that the greatest noise was at the end?" *A.*—"Yes." Nevertheless, other ear-witnesses (generally those who were at a greater distance from the scene) speak confidently to two explosions in very rapid succession, "like the report of a
246 double-barrelled gun,"* or, "I heard one report, then a sort of rumbling noise, and then another report." One witness (Pegram) asserted that the first
221–7 explosion brought him out of a shed in which he was, and that he was outside when he heard the second.

It may, the Committee consider, be regarded as certain that there were two explosions, but that the explanation of their having appeared as one is to a large extent suggested by a reply of one of the witnesses
227 (Pegram), who said, "The whole thing was so instantaneous that before the rumbling of one explosion had ceased the other one occurred." The first explosion, it may be assumed, established what has been described as "the rumbling," and this rumbling ran into, and was punctuated by the second.

* This expression was used by Captain Huleatt to one of the members of the Committee.

Evidence as to which of the buildings exploded first.

But to which of the buildings must the initial effect be attributed? It will easily be understood, in view of the difficulty of obtaining evidence as to the occurrence of two explosions, how much greater the difficulty was likely to prove when the Committee sought to ascertain which building went first. Indeed they have only succeeded in obtaining the evidence of one witness who is prepared to speak at all positively on this point, and that witness is Pegram, who expressed himself very confidently to the effect that the store exploded first, and the washing house second. This impression he derived from the fact that he saw, or believed that he saw, the débris of one building (which according to his description must have been the store) in the air, before the débris of the other (the washing house) rose. 221–9

The Committee are constrained to believe that this witness is mistaken, and they are far from satisfied that anything like the interval which his statement involves, really occurred between the two explosions. Not only is his evidence unsupported, but it is inconsistent with what must be regarded as the reasonable probabilities of the case. 897–8 683, 699, 898 960–1

Condition of store and its contents at the time of the explosion.

On the one hand, in the store house the only explosive present was a quantity of carefully purified nitro-glycerine, lying undisturbed in store tanks. The Committee have satisfied themselves, from an inspection of the books and the examination of witnesses, that it would be in the very highest degree improbable, and contrary to all the experience of the factory, that there could have been in the store house any nitro-glycerine in other than a thoroughly purified condition. They consider it is still more improbable, and indeed impossible, that there could have been present any nitro-glycerine in such a condition as to give rise, on a cool day and under conditions unfavourable to turbulent chemical action, to spontaneous decomposition and explosion. No work whatever was in progress in the house, and no one was present therein or thereat; the house itself was locked up.

Condition of the washing house and its contents at the time of the explosion.

On the other hand, in the washing house there was work actually in progress; there were apparatus and implements for carrying on that work, and a quantity of warm, and therefore highly sensitive nitro-glycerine; there were moreover the risks (such as they are) attending the presence of a workman, engaged upon some operation. As to the precise character and extent of these various risks, it will be the duty of the Committee to speak more definitely hereafter. For the moment it is sufficient to indicate that, whereas, in the one house, the risk of accident was inappreciable, in the other house several possible causes suggest themselves, and the Committee cannot accept the statement of a single witness as sufficient to transfer the heavy balance of probabilities from the one building to the other.

Further, although no direct evidence is forthcoming to show that the washing house went first, some cogent indirect evidence is supplied by the fact that several of the witnesses appear to have recognized an increased violence of effect at the end. Mr. William Thomson distinctly says that the greatest noise was at the end. 152 The Superintendent (Colonel McClintock) said the same. 598–9 Mr. Jackson heard "a kind of rumbling sound and then one loud report," "very loud;" he heard no other report. 393, 400 And this would hardly be consistent with the fact that the explosion of the 1,500 lb. (in the washing house) followed the explosion of the 2,200 lb. (in the store house), which was contained in one single tank, while the washing-house nitro-glycerine was distributed in two tanks, and was more or less mixed with water.*

Consideration of suggestion that the explosion was the result of foul play.

Before leaving this branch of the subject, and before finally passing away from the suggestion that the store house went first, the Committee think it desirable to say a few words on the question of whether it is probable that the disaster can have resulted from foul play, in other words, from the placing within, or at, the store house of some contrivance for effecting the explosion.

The Superintendent expressed a decided opinion, not only that oppor- 609–13

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* Since this report was prepared, the Committee have received information to the effect that Mr. Roddick, a farmer, who resides just outside the boundary of the Quinton Hill Factory, was, at the time of the explosion, in a room of his house in a position almost facing that occupied by the witness Pegram, when he heard two explosions, succeeding each other very closely. He states that, on looking out of the window, he saw a column of smoke in the air, and that, immediately afterwards, a second rose on the *right* of the first one. This statement would appear to be confirmatory of Pegram's view that the nitro-glycerine store exploded first. On the other hand, Mr. Roddick has stated very positively that the second column of smoke and débris rose to the greater height, and this accords with the conclusion the Committee arrived at, that the store containing the largest amount of nitro-glycerine exploded last.

tunities for effecting the explosion by such means existed, but that in fact this
609 was the means by which it was produced. Indeed, he said he could see no other explanation, and Dr. Dupré, though not himself accepting this explanation,
683 intimated that no other explanation would reasonably account for the first explosion having occurred in the store house, if such could be established to have been the case.

So far as the Committee can discover, the only grounds for suspecting foul play are—

1. The belief that the store house exploded first.

2. The difficulty of accounting for an explosion in the washing house.

But if, as the Committee believe, there are no sufficient grounds for accepting the view that the store house went first, but rather that, on the whole, the balance not only of probability, but also of indirect evidence, tends to support the opposite view, then this, the main ground for believing in foul play practically disappears. And if, as the Committee believe they are able to show, the second ground for accepting this theory of the disaster is not, as a matter of fact existent, if, that is to say, they can demonstrate that more than one explanation of the possible occurrence of an accident in the washing house may be offered, then the case against the foul-play theory seems to be reasonably complete.

Existence of a public right of way through the factory.

At the same time, the Committee desire to express their opinion that the arrangement under which, as they have learned to their surprise, the public
503–12, 544–6, 579 have on Sundays a right of way through the factory,* is open to the very strongest possible condemnation, and should be immediately modified. Moreover the protection of the factory generally against the presence of unauthorized persons appears to be at present extremely unsatisfactory. Attention may be
584–6, 613–6, 624, 668–79 directed to the evidence of Colonel McClintock and of Colonel Sale on this point, as establishing an urgent necessity for comprehensive reform in this direction.

Professional advice taken by the Committee on the question of the origin of the explosion.

But, as the Committee have stated, it is not in the direction of foul play that the explanation of this accident may be most reasonably looked for. In their judgment the explosion undoubtedly originated in the washing house, and they have accordingly examined with the strictest attention every possible cause of an accident, and have availed themselves of the assistance of gentle-
680 men specially qualified to advise on this matter, such as Dr. Dupré, F.R.S., Chemical Adviser to the Explosives Department of the Home Office and an
777–8 Associate Member of the Ordnance Committee; Mr. McRoberts, who was
787 the original manager of Nobel's Ardeer factory for about 19 years, and who
864 was also consulted in regard to the works at Waltham; Mr. Guttmann, formerly connected with Nobel's works on the Continent, and now acting as Technical Adviser of the National Explosives Company (Limited); Mr. Lund-
750 holm, who has been manager of Nobel's Ardeer factory since 1889; and Dr. Kellner, Chemist to the War Office.

They have also examined Mr. James Thomson, the manager of the Quinton Hill factory, who has had the training of 9 years' experience
3 at the Ardeer works under Mr. McRoberts; Mr. William Thomson, chemist
793–5 at the guncotton factory and formerly employed in the nitro-glycerine factory; and the surviving persons who had been usually employed in the exploded houses and adjacent buildings. They have, also, by personal visits to the site, and otherwise, diligently investigated every circumstance or suggestion which seemed to them likely to furnish a clue to the originating explosion. They regret to say that they find it impossible to pronounce confidently as to which, of several possible—though generally, it must be admitted, improbable—causes the accident was due.

General safety of a final-washing house.

The whole of the witnesses examined on this point are agreed that a
704, 754, 797, 803–5, 919 final-washing house is relatively an extremely safe house, and, so far as the Committee are aware, only two instances are on record of explosions in final-washing houses, viz., one at Krümmel, which is confidently believed to have

* The circumstance that the accident occurred on a Monday, the day succeeding that on which the public are allowed to pass at their will through the factory, and only a few yards from the exploded houses (Question 507), perhaps in part suggested, or seemed to lend a certain reasonableness to, the foul-play theory.

been due to a workman trying to force a frozen earthenware cock, and one at Schlebusch in 1892, due to lightning.* Mr. McRoberts testifies that, although 930-1, 932
the difficulties and risks involved in developing the manufacture of nitro-glycerine on a large scale in the early days were many and formidable, no 779-80
such risks disclosed themselves in the final-washing house, and it is interesting, 838-9
as bearing on the question of the safety of final-washing houses, to notice that at Ardeer an apparatus practically identical with that employed in the washing house at Waltham has been in use from about 1887, and that during that period a quantity of nitro-glycerine exceeding the very large amount of 11,400 tons† has been manufactured with this apparatus without 918-19,
accident. At Waltham Abbey about 440 tons (879,872 lb.) of nitro-glycerine 938-9
have been made without previous accident. 617

Nevertheless it appears to the Committee, after a careful examination of the system of operations, that more than one source of risk, each in itself, perhaps, remote, but still a source of risk, existed in connection with the washing house.

Improbability of explosion being due to turbulent chemical action.

At the outset it may be as well to dispose of one hypothesis, that the explosion might have been due to the accidental establishment of turbulent chemical action, resulting in ignition or spontaneous decomposition. In the opinion of the Committee this theory of the cause of the accident may be quite confidently dismissed. Not only did no nitro-glycerine enter this house except such as had undergone complete separation from the acids, and a pre-washing,‡ but, as has been shown,§ there can be no reasonable doubt that both batches of nitro-glycerine in the house were considerably advanced towards purification up to the high standard established in connection with the Waltham Abbey products.‖ One batch had almost certainly undergone its third washing and was thus very nearly finished, the other was undergoing its second washing. There was no other nitro-glycerine in the house.¶

Even if Mr. Guttmann's views as to the risk involved in the use of some- 881
what strong soda-solutions for washing were accepted as sound, his observations need inspire no anxiety in this connection, for, as he himself admitted, any instability, which the use of such solutions would tend to establish, would be unlikely to declare itself until after the lapse of a "year or so." And there is 885-6
evidence that stronger soda-solutions are used at Ardeer without any such results, whether immediate or remote, as those apprehended by Mr. Guttmann. 973-6

The Committee therefore agree with Dr. Dupré that "we may leave out 685
of consideration the idea of the explosion having been due to spontaneous ignition of the nitro-glycerine."

Probability of explosion being due to mechanical rather than chemical sources of risk.

It is to what may be regarded as mechanical or physical (as distinguished from chemical) sources of risk that we must look for an explanation of this accident. And it has been pointed out to the Committee that, in one respect, a condition of things prevailed which was specially favourable to the development of a risk of this sort, viz., in the comparatively very sensitive character of the heated nitro-glycerine present in the house (due to the high tempera- 683-687
ture of the wash-waters employed),** which rendered it much more liable to 755-7, 822, 870-1, 924,
explosion by friction or percussion than when it was cold. It is important to 957
bear this in mind, in considering the possible risks, because otherwise, and notwithstanding the well known dangerous sensitiveness to percussion or friction of even cold nitro-glycerine when spread thinly on metal or other hard surfaces, the existence of a risk which would only become formidable with warm and therefore exceptionally sensitive nitro-glycerine, might be overlooked or doubted.

Sensitiveness of nitro-glycerine increased with increase of temperature of wash-waters employed.

It may be suggested that the use of wash-waters at temperatures approaching 50 degrees Centigrade (122 degrees Fahrenheit), which the technical advisers

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* *See* also Annual Report of Her Majesty's Inspectors of Explosives for 1892.

† Mr. Lundholm introduced the present apparatus in 1887; he did not become manager of the Ardeer factory until 1889, and the amount of 11,400 tons of nitro-glycerine has been manufactured during his management.

‡ "It is pretty safe after the pre-washing" (McRoberts, 856.)

§ *See* page 6.

‖ At Waltham Abbey the "heat test" is carried on at a temperature of 180 degrees Fahrenheit, while the Home Office test for the products of private manufacture is carried on at 160 degrees Fahrenheit. 90

¶ *See* pages 4 and 6.

** *See* page 3.

of the factory must have been aware, could not fail to sensibly reduce the practical margin of safety, by rendering the nitro-glycerine much more sensitive, was in itself an imprudence; but, although in the judgment of the Committee it would probably be judicious in the future to employ wash-waters of somewhat less elevated temperature,* it is hardly possible or fair to characterise the use of these very warm waters as positively imprudent, or as necessarily liable to produce an accident. It is true that
923 at Ardeer the temperature is less than it was at Waltham, though the mixture is still sufficiently hot to render the nitro-glycerine highly sensitive, but at
1070 Krümmel and Schlebusch the solutions used are hotter than at Ardeer, and the nitro-glycerine therefore attains a higher temperature,† but no explosion traceable
923 to this cause has ever occurred. At Ardeer the temperature of the solution was at one time at least as high as, if not rather higher than, at Waltham, and Mr. McRoberts informed the Committee that he had even employed for some time, experimentally, solutions 30 degrees Centigrade higher than those
859-62 employed at Waltham (*i.e.*, 80 degrees Centigrade, or 176 degrees Fahrenheit), which raised the temperature of the nitro-glycerine some 10 degrees higher.

Use of wash-waters of more moderate temperature recommended.

Therefore, having regard to the facts that the higher temperatures appear to facilitate and accelerate the purification of the nitro-glycerine, that the Government standard of purity is a very rigorous one, and that the requirements of the Service demanded that the productive power of the factory should be developed to its utmost, consistently with what was believed to be safety and efficiency, the Committee are not prepared to go so far as actually to stigmatise as imprudent the use of solutions of the temperature of those actually employed at Waltham, although, speaking after the event, they are of opinion that their use may very probably have contributed to produce the accident, and that, for the future, it would be wise to employ wash-waters of more moderate temperatures.

Sources of risk present at Waltham Abbey, of a mechanical nature.

The existing sources of risk, so far as the Committee have been able to ascertain them, may be classed and most conveniently disposed of under the heads, respectively, of special and general risks.

Special Risks.—Among those which have been suggested to the Committee, the following seem to invite particular consideration:—

684, 723, 819-22, 871-5
1. Risk from a blow or friction due to the fall or violent movement of the leaden skimmer.

684, 811-3, 926-9
2. Risk from use of earthenware cocks.

684, 857-8
3. Risk from friction established by the leaden air-pipe.

685-6
4. Risk from the fall or use of some article commonly present in the washing house.

General Risks.—Many of those risks which the Committee signalised in their Report of 25th April, 1894, on the accident of the 13th December, 1893, in the cam house at the Royal Gunpowder Factory, undoubtedly existed in the present instance, and some even in an aggravated form, with such further sources of risk as would be liable to result from the public "right of way" before referred to, and to the extremely insufficient protection against the presence in the factory of unauthorized persons.

Special Risks.

The Committee proceed to deal with the special risks in the order in which they are specified above.

1. *Risks from a blow or friction due to the fall or violent movement of the skimmer.*

Possibility of risk arising from irregularity in working of the skimmer.

Of the various sources of possible risk this one stands out prominently.
871-5 Mr. Guttmann has expressed a confident opinion that to this cause the accident
684 was certainly due; Dr. Dupré is strongly impressed with the possibility of an

* Mr. Lundholm stated to the Committee that since this accident the temperature of the wash-
924 waters at Ardeer has been reduced by 10 degrees Centigrade.

† It may be well to notice that at both the factories the nitro-glycerine is allowed to cool
1070 down to 30 degrees and 25 degrees Centigrade (86 degrees and 77 degrees Fahrenheit) respectively, before drawing off.

accident from this cause; Mr. McRoberts thinks the arrangement one which "might give rise to some trouble," and "produce an explosion if it knocked against the side of the tank;" Mr. James Thomson, apparently, was not free from doubt as to the possibility of risk from this cause, although the experiments which he subsequently made rather tended to remove that doubt. The question is not so much whether a fall of, or friction caused by, this skimmer (which is practically a leaden perforated bowl of about 36 lb. weight) would be liable under favourable conditions to produce an explosion, for it is scarcely disputed that such would be the case. Dr. Dupré has established experimentally that nitro-glycerine at 50 degrees Centigrade (122 degrees Fahrenheit) may be readily exploded between lead and lead by a 1 lb. weight falling from a height of 45 inches. Mr. Guttmann stated that "a weight of 28 lb. falling 1 foot on nitro-glycerine never failed to produce an explosion," and he concludes that nitro-glycerine (especially when warm) receiving, between lead surfaces, such a blow as the skimmer falling even 2 feet, would be capable of delivering, would be liable (though not perhaps invariably) to explode. Mr. McRoberts has in his experiments more than once exploded even cold nitro-glycerine with a blow by lead upon lead. It is unnecessary to labour this point, which the Committee's own experience justifies them in saying may be accepted, apart from any evidence taken by them. 819-20 1026-31 1043 684 871 872 820-1

But the question rather is whether such a blow, or friction, could, or would be likely to, be brought about by the skimmer.

Possibility of irregularity in working of the skimmer being of such a nature as to cause an explosion.

The skimmer was suspended by a pulley above the washing vat, and secured in its position by the cord being twisted round a staple beside the tank. Although in the experience of the factory such a thing as a skimmer "coming down with a run" has never occurred, this contingency cannot be regarded as impossible. 216, 255, 357, 1032

It might happen from one of three causes—

1. The pulley itself carrying away.
2. The rope breaking.
3. The rope slipping out of the man's hand when he was about to secure it.

It is significant that the man Strange, who worked in this washing house, although he had never known the cord to break, had known it to slip, though not to such an extent as to lower the skimmer sufficiently to touch the nitro-glycerine, and he admitted that if the men were not careful it would "come down with a run." But if it did come down with a run, could it strike such a blow or establish such friction as would produce an explosion? The evidence generally tends to show that the blow would have to be struck on a metal or other hard surface thinly covered with nitro-glycerine. When the tank was full, the only chance of this would be the striking by the skimmer of a glancing blow against the side, and, owing to the rather stiff indiarubber tube which tended to keep it central, this would be very unlikely. Indeed, in Mr. Thomson's experiments it never occurred or never even nearly occurred. Still, it is not, in the judgment of the Committee, impossible, and if the indiarubber pipe were accidentally to become detached (which might perhaps happen if the skimmer were pulled up too high or too abruptly), it would be not at all unlikely to occur.* 256-7 260 1026-31, 359

As regards striking the bottom, Mr. Thomson's experiments tended to show that the indiarubber pipe would here again be useful in preventing the skimmer from striking violently against the bottom; and it is almost certain that at the time of the accident, both the tanks contained liquid: in one, there was perhaps nitro-glycerine only (after the removal of the third wash-water), but in such a quantity as to prevent the sharp impact of the skimmer on a thin layer of nitro-glycerine on the bottom; the other tank probably contained both nitro-glycerine and soda-solution, and the conditions necessary to the delivery of such a blow as has been described, would here be even less favourable. Accordingly, if the blow which caused the explosion was struck by the skimmer, it may be reasonably concluded that it is most likely to have been struck

* It is not unworthy of notice that a new indiarubber pipe had been fitted on the Saturday previous to the accident. 377

against the side of the tank, an occurrence which, though scarcely probable, is not impossible, and which would be less improbable if the skimmer had been raised to a height preparatory to the inflow of a fresh soda-solution (as might be the case after the completion of the third washing), and might even be regarded as not improbable at all, if, by any chance, the pulley itself had become detached, and had come down with the skimmer.

Use of skimmer is not unattended by risk.

The Committee recognize the difficulty of reproducing experimentally the conditions necessary to the delivery of such a blow as would have been required to produce the explosion by the fall of the skimmer, and they fully admit the importance to be attached to the circumstance that, never since this factory was established, has any such accidental fall of the skimmer occurred; they also thoroughly recognize the importance of the facts, that, at Ardeer, the apparatus has been used in connection with the manufacture of a quantity of
940 nitro-glycerine, exceeding 11,400 tons, without mishap, and that in no single instance, during the seven years that it has been in use at that establishment, has the skimmer been known to descend with dangerous rapidity, or to fall; yet, with these circumstances before them, they feel constrained to express their opinion that the use of this apparatus is not unattended by risk, from the causes above indicated, and that, among the possible causes of the explosion now under notice, the fall or dangerously rapid descent or accidental swing of the skimmer must occupy a foremost place. To say that this source of risk is not a very probable one, is scarcely to the point, for an explosion in a final-washing house from any cause is, as the Committee have shown, intrinsically improbable. Had there existed in this house or in other final-washing houses, one or more probable causes, accidents in such places could not have failed to be of more or less frequent occurrence; but experience has shown that they do not occur. It follows, therefore, that when such a very improbable thing as an explosion in a final-washing house does occur, it can scarcely fail to have been originated by what must be considered as in itself an improbable, or rather not very probable, cause; and among such causes it appears to the Committee that the fall of the skimmer stands out as less improbable than most of the others that have been suggested.

2. *Risk from use of an Earthenware Cock.*

171–4

Possibility of risk arising from irregularity in working of the earthenware cocks.

811–3, 926–9 It is acknowledged that risk of a serious character may arise from this cause. Indeed, the only recorded previous explosion in a final-washing house (apart from an explosion due to lightning*) is considered to have been due to
930–1 this cause. But the particular conditions which produced the accident in
175–7 question, and with which this risk is mainly associated, did not exist in the
926 present instance, for the temperature on the day of the accident was considerably above that at which nitro-glycerine freezes. At the same time, it must be noticed that Dr. Dupré signalized, and Mr. McRoberts's experience confirms the observation, that risk of a tap sticking would arise even in warm weather, and any striking of the same or other application of force in an attempt to turn the tap, would obviously be attended with grave risk. As Dr. Dupré
684 points out, "If you warm a tap outside, you ease it, but if you warm it inside, you make it stick, and during the time of the washing, the material inside the tub may have expanded the tap inside, and then it would require force to turn the tap, and when force is used for such a purpose, there is always serious
811–3 danger." Mr. McRoberts says, "I have known taps get tight, but when they did that, we put cloths soaked in warm water on them." *Q.*—"Would that be the case not merely in cold and frosty weather, but also in warm weather, should they happen to stick?" *A.*—"Yes."

It will be observed that the evidence of any such risk in warm weather
177 was not recognized by Mr. William Thomson, who for some time was in charge of this factory, or even, so far as his evidence goes, by Mr. James Thomson,
72 and it may therefore be reasonably assumed that it was not a risk generally recognized in the factory. And this risk, therefore, must be included among the more probable causes to which the accident is not unlikely to have been due.

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* *See* page 8.

3. *Risk from Friction established by the Leaden Air Pipe.*

Possibility of risk arising from irregularity in the working of the air-pipe.

In regard to the pipe, Dr. Dupré remarks that it "had actually no fixture, 634
and when the air was sent through it, it was sure to vibrate and rub against the bottom of the tub, it might even knock against the side," and he is of opinion that in the highly heated state of the nitro-glycerine this would constitute a risk. Without attempting to assess the precise degree of probability attaching to this suggested cause, the Committee agree with Dr. Dupré so far as to say that, in their judgment, even a very remote risk, possibly ascribable to this cause, is of sufficient importance to render it desirable that the plumbers engaged in fixing these pipes should be instructed to apply some method of so firmly securing them as to prevent them from having any appreciable motion imparted to them, by the passage of the air.

Whether in the course of the renewal of these pipes, which was effected 366-71
on the Saturday immediately preceding the explosion, anything was done, or left undone, which would tend to aggravate any risk from this cause, it has not been possible for the Committee to ascertain. But the fact that the day of the explosion was the first working day after repairs or alterations had been effected in the apparatus, does not tend to diminish whatever suspicion may attach to this particular source of risk.

4. *Risk from the fall of some article commonly in use in the Washing House.*

Possibility of risk arising from irregularity in the use of various articles in the washing house.

Dr. Dupré in his evidence enumerates the various articles commonly 685
present in the washing house, and among these are the following: glass beakers, glass bottles, earthenware skimmers, slates (framed), copper bands and rings, lead weights. It is quite certain that in a house containing a quantity of heated, and therefore highly sensitive, nitro-glycerine, the presence of certain of these articles would constitute a very appreciable risk, and there is no doubt that if any one set himself to do it, he could produce a nitro-glycerine explosion without great difficulty, with almost any of these articles, especially those of earthenware and of glass. What can be done deliberately might also be done accidentally, and the Committee are constrained to believe that the presence of several of the articles—of earthenware, glass, and metal —mentioned in this list, constituted an appreciable risk, which in the examination of all possible causes cannot be properly ignored.*

If, as Mr. Guttmann is of opinion, there were also present throughout the
interior of the building appreciable quantities of nitro-glycerine which had been 870-1
vaporised and subsequently deposited upon some part of the interior of the house, resulting from the employment of the hot soda-solutions, this would tend to aggravate the risks arising in connection with the presence of the earthenware, glass, and metal articles above referred to—if, indeed, it did not otherwise create risks of its own. And if, further, as there seems from the evidence of 300
Strange, to be no doubt, splashing or falling of nitro-glycerine on to the floor occasionally occurred, the risk from the presence of a number of metal, glass, and earthenware articles would be of course greatly increased.

General Risks.

General risks:—

The Committee do not think it necessary to recapitulate the risks which they specified in their report of 25th April, 1894, on the accident of the 13th December, 1893, in the Gunpowder Factory, but it is proper to remark that of these, several existed, some even in an aggravated form, on the occasion of the present accident. Thus, although, according to the evidence of the Superin- 625
tendent, the system of searching has been greatly improved since the accident

E.g., arising from defects in the system of searching.

* On the occasion of the loss by explosion in 1882 of the sample magazine at Ardeer, the accident was, after careful investigation, attributed to the fall of a bottle or bottles on to the floor, caused probably by the fall of the man who was carrying the same. (*See* Annual Report, 1882, page 135, 91, Special Report XLI., 29th June, 1882.)

of the 13th December, it is certain that full effect had not yet been given to the recommendations of the Committee on this head. The Committee's report had not up to that time got into the hands of the factory staff, and thus the possibility of the existence of matches or other dangerous articles within the nitro-glycerine factory cannot be confidently disregarded.

298–305 Moreover, it transpired that it is the practice to allow the men employed in the nitro-glycerine houses to wear the boots (without iron nails) supplied for their use in the houses, outside the houses, and having regard to what has been said as to the public having access to the factory every Sunday, and to the generally unprotected condition of the factory against unauthorized persons, the possibility of a match being conveyed into the house on the soles of the boots must be recognised. The practice of allowing the men to walk into and out of houses containing nitro-glycerine without changing their boots is objectionable, on the ground that it tends to convey grit into those houses; and although the risk of explosion of even heated nitro-glycerine on a wooden floor* from this cause may be of a somewhat remote character, the margin of safety is undoubtedly thus, in however small a degree, reduced, while the moral effect of any relinquishment of precautions is objectionable. It is also in the judgment of the Committee not desirable that a practice which is prohibited by the Explosives Act, 1875,† and which is, therefore, not allowed in private factories should be permitted in one of the Government factories.

Or from use of "clean" shoes outside danger buildings.

The Committee have no reason to believe that the system, or want of system, which prevailed in the Gunpowder Factory in regard to some other matters, had undergone any sensible modification in the cordite factory, though it is not unreasonable to assume that the previous long training of Mr. James Thomson in the nitro-glycerine department of the Ardeer factory must have secured the application, in a large degree, of the more thorough system of supervision and inspection, of which he had acquired experience under the Home Office regulations in force at those works. It is, however, important to observe, in connection with a suggestion by Mr. McRoberts in the addendum to his evidence, as to the possibility of the accident having occurred from some incautious act on the part of a workman with a view to repair, or control a leak, or fracture, or other sudden failure on the part of the apparatus, that the remarks of the Committee on the question of repairs in danger buildings assume special significance.

Appendix XIII.

Without, however, going through the various points in detail, the Committee desire to express their opinion that the whole of the regulations affecting the cordite-factory should be comprehensively revised, in the directions indicated for the Gunpowder Factory Regulations in the former report of the Committee.†

Revision of regulations for cordite-factory required.

Having shown that the weight of evidence goes to establish that the explosion originated in the washing house, it is necessary to consider by what means this explosion was communicated to the nitro-glycerine in the store.

Suggested means by which the explosion from the washing house was communicated to the store:—

It would appear from the evidence as to the almost simultaneous occurrence of the two explosions, that the second explosion could not possibly have been due to débris projected from the washing house. The period of time which débris must have taken in travelling the 61 yards which intervened between the two houses would, even had the houses been unprotected by traverses, have been much greater than the very brief interval which evidently elapsed between the two explosions.

By projection of débris from one house to the other.

It is not less certain that the explosion could not have been due to the flash from the first explosion, for the store was considerably outside the range of such flash, and those buildings which were much nearer to the washing house (*e.g.*, the nitrating houses), and more exposed to the flash, were not exploded, whilst a man (Player) and a lad who were working between the two houses at the moment of the explosion, and not more than 12 yards from the store, although they saw a "dull red flash," sustained no injury.

By flash.

440–5

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* *See* remarks on page 12, as to occasional presence of spilt nitro-glycerine on the floor. Question 298-304.

† *See* Order in Council, No. 2, § 8. "Due provision shall be made by the use of . . . . suitable shoes . . . for preventing the introduction of any . . . grit into any part of a danger building where it would be likely to come into contact with explosives."

‡ *See* Report of 25th April, 1894, pp. XVIII.-XX.

By sympathetic action.

It has been suggested that the second explosion was due to sympathetic action. As bearing upon this suggestion, reference may be made to the remarkable experience of Mr. McRoberts at Ardeer in 1874, which is thus described in his evidence: "I recollect another accident which happened in 1874, when the pond containing about 3 tons of nitro-glycerine blew up; I was within about 60 feet of the place when it exploded, and I was covered with sand, and there were two men washing a tubfull of nitro-glycerine at the edge of the pond the very moment it exploded. The tub was broken into staves, and the nitro-glycerine was scattered all round, but it was not exploded at all." 828

In reply to a question by the Committee as to whether the store house at Waltham Abbey could have been "exploded sympathetically" by the washing house, Mr. McRoberts replied "That would be simply impossible; it could not be; if it exploded at all it must have been by some direct contact." 829

By means of the channels leading from one house to the other.

Another method by which the second explosion may have been caused was suggested by Mr. Guttmann, who strongly held the view that "the explosion was communicated from the washing house to the store by means of the channels" (*i.e.*, the V-shaped leaden gutter in a wooden tunnel), along which the nitro-glycerine was conveyed by gravitation from the washing house to the store. Mr. Guttmann explained to the Committee at considerable length the grounds for this opinion, and these have received the most attentive consideration at the hands of the Committee, of whom some visited Waltham and re-examined the débris, and the remains of the leaden gutter, with especial regard to Mr. Guttmann's suggestions. They feel constrained to express their opinion that the facts do not support Mr. Guttmann's view, and indeed that the main indications on which he relied in support of his theory are properly ascribable to other and very simple causes. 886

By the destruction of the store building itself, enclosed entirely as it was by its traverse.

In the opinion of the Committee, the explosion of the nitro-glycerine in the store was due to the destruction of the building itself, partly by the concussion, but mainly by the powerful air-wave created by the sudden development of the large mass of enormously heated gases, and by the scarcely less sudden reaction due to the contraction of this heated body of permanent and non-permanent gaseous products. The effect of such an air-wave is to destroy, partly by compression, partly by the instantaneously succeeding exhaustion and reaction, any buildings directly exposed to its effect, and when, as was the case at Waltham, such buildings are completely enclosed by high steep traverses (with very small openings for the escape or expansion of the air), these effects must be intensified. This was shown in a very marked manner at an explosion (of $3\frac{1}{2}$ tons of gunpowder), which occurred at Messrs. John Hall & Son's "Marsh" Works, Faversham, in 1879, when houses situated in pits were very much more seriously damaged than houses much nearer to the explosion, the traverses or mounds about which were not continuous.* 999

Objections to continuous traverses.

The Committee had the advantage of hearing the views of Sir Benjamin Baker on this subject, and, in reply to a question as to whether the results above referred to, as having been exhibited at Messrs. John Hall's factory, "do not go rather to show that, having a pit around a house, tended to increase the concussive or vacuum-effects," he said, "Yes, I think so." 999

Sir Benjamin Baker is, however, strongly of opinion that, if proper attention be paid to the construction of a house by so arranging the boarding or other material forming its sides, as to yield readily to suction and to pressure, no material injury to the house would result from even the violent atmospheric disturbances which are established by a powerful explosion, notwithstanding that the building be completely in a pit. 994–1000 999

It scarcely falls within the province of the Committee to pronounce, at any rate in connection with this particular accident, as to the practicability of adopting this sort of construction consistently with the fulfilment of certain essential requirements in a danger building, but the matter is one which may, perhaps, profitably occupy the attention of the Works Department.

Meanwhile, until a satisfactory plan of construction on the lines indicated

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* *See* Special Report by Major Majendie, dated 17th March, 1879.

by Sir Benjamin Baker may have been worked out, it seems clear to the Committee that it is undesirable so to surround danger houses with uninterrupted traverses or mounds, or so to place them in pits, as to intensify (as the Committee believe was the case in the recent explosion), the effects due to the violent compression and reaction which follow a powerful explosion.

Not only are such effects destructive to the house itself, but they are also liable, through its violent destruction, to explode the explosive material present in the broken up building. In the opinion of the Committee the explosion of the nitro-glycerine in the store was brought about in this way, being due to the disturbance of the building itself, and to the violent projection of its débris into the explosive liquid, and was not ascribable to the action of the débris projected from the original explosion,* nor to sympathetic action, nor to the transmission of detonation.

Summary of Committee's conclusions.

To sum up, the Committee desire to report—

1. That the accident of the 7th May originated in the washing house, causing the explosion of about 1,500 lb. of nitro-glycerine therein.

2. That it is impossible to say to which of the various causes assigned or indicated by the Committee the explosion was primarily due, though, on the whole, it is most probably to be found among the four special risks which have been discussed above.

3. That the original explosion was followed almost instantaneously by the explosion of about 2,200 lb. of nitro-glycerine in the store.

4. That the second semi-simultaneous explosion was most probably caused by the crushing and breaking up of the store house, due to the violent atmospheric disturbance established by the first explosion.

5. That the traverses surrounding the two exploded buildings, as also those about the nitrating houses and other buildings (although calling for some material improvement in design), afforded valuable service and undoubtedly tended largely to limit the effects of the disaster.

6. That, in several details, the system of manufacture and supervision, the precautionary regulations and details, the distribution, and to some extent, the protection, of the buildings call for modification and improvement; but

7. That the Committee are not able to say that this accident was due to any shortcoming in these respects, which can be particularized, nor that any special blame in connection therewith attaches to the staff of the factory, or to any of the employés.

IV.—Suggestions for the Prevention of Accidents.

The remarks of the Committee on the cause of the accident will probably have sufficiently indicated many of the directions in which reform and reorganization are called for, especially in matters of the details of manufacture and the revision of the regulations. But there are two points to which the Committee think it their duty particularly to advert.

Position of the nitro-glycerine factory and distribution of the buildings.

The first has reference to the very important question of the position of the factory and the distribution of the buildings. Although, perhaps, this

* On a much smaller scale the same thing was illustrated in an explosion which occurred in a fulminate mixing shed at Messrs. Joyce's factory near Waltham on the 22nd December, 1893. On that occasion an explosion occurred during the mixing of some cap composition, and the building was destroyed. The noise of the explosion attracted a number of men to the spot; just as they arrived, a second explosion occurred, which killed one of the men who had gone to help, and injured others. This was due to the débris of the exploded building falling on a batch of cap composition in a gutta-percha bottle which was just inside the door of the house, which had escaped the first explosion but was exposed to falling timbers from the house itself. (*See* Special Report, No. cvii., dated 30th December, 1893.)

branch of the subject falls more strictly under what, in their first report, the Committee call the second portion of the enquiry entrusted to them, viz., the disposition of the danger buildings of the Government factories generally, the Committee think that it will be well that they should, without further delay, intimate their plain and decided conviction that the position, or perhaps more strictly the distribution, of the buildings composing the Quinton Hill factory, and more especially that part of it which concerns the manufacture of nitro-glycerine, is eminently unsatisfactory. A glance at the plan which accompanies this report must at once suggest to any one familiar with the distribution of buildings in a factory for explosives, that the buildings, or at least the greater part of them, are much more crowded together than is safe or proper. On the other hand, there are large vacant spaces, which the Committee understand from the evidence of the Director-General of Ordnance Factories, are, by the terms of the agreement of purchase, non-available for the erection of, at any rate, dangerous buildings. Whether this agreement would extend to prevent the erection thereon of buildings for the manipulation of explosives of such a character that no risk to surrounding property could arise therefrom (*e.g.*, cordite in certain stages of manufacture or manipulation), is a point on which the Committee are not in a position to express an opinion. Indeed, they desire that their remarks on this subject should for the present be of a general character; and speaking generally, they say unhesitatingly that, as at present disposed, the factory at Quinton Hill is not suitable nor adequate in point of position, arrangement, and extent to such an output of nitro-glycerine and cordite as has recently been coped with, in regard both to the safety of the work-people and the public, and to the important consideration that, as in the present case, a single accident may paralyse the whole manufacture of a Service-explosive for many weeks, perhaps months. It will be seen that practically these views are shared by the Director-General of Ordnance Factories. The Committee are therefore strongly impressed with the urgent necessity for the immediate adoption of measures for—

Appendix I.

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479–502

(*a.*) Redistributing the buildings of the present factory in such a way as to conform to reasonable conditions of safety; and—

(*b.*) Adapting, (which must mean reducing), the output to the conditions of the factory when such redistribution has been effected; and—

(*c.*) Establishing a duplicate factory on some suitable and separate site.

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Restriction of out-put, and immediate preliminary incorporation of nitro-glycerine as soon as manufactured.

If, as the Committee understand, the exigencies of the Service demand the temporary use of the factory as at present arranged, when the damaged buildings and works (duly modified in design, so far as practicable, to satisfy the experiences of the recent disaster), have been re-erected, then the output should be reduced to what may, for the time, be absolutely necessary, and any accumulation of explosives in a dangerous form should be avoided as far as possible. Thus, the Committee, after giving full weight and consideration to the reasons which have been advanced for the existing practice, are of opinion that it would not only be desirable but practicable, to avoid having any store of liquid nitro-glycerine. They consider that the successive batches of purified material should be forthwith absorbed into guncotton, in which condition it will be far less formidable than when in the liquid form. This is in effect what is done (indeed, by the terms of the licences granted by the Home Office, is required to be done) in all the private factories of nitro-glycerine preparations. And there can be no reasonable doubt that, had this been done at Waltham Abbey, there would have been no second explosion on the occasion of the recent disaster.

Provision of skilled chemical supervision.

The other point to which the Committee desire to call particular attention is, the question of supervision. It is not only necessary that in a factory which includes the manufacture of nitro-glycerine and guncotton as well as of cordite, competent chemists should be attached to and charged with the immediate supervision of the several departments. This, as far as the Committee are able to form an opinion, was attended to at Waltham, and, in Mr. James Thomson and his assistant chemists the several departments of the cordite-

factory were well provided in the matter of skilled supervision. But the Committee are of opinion that a factory like that at Waltham Abbey, and more especially that branch which deals with the manufacture of chemical explosives, should have the constant services of a chemist of high standing and of long special experience in these departments of chemical industry, and that this official should have responsible control over all the manufacturing operations, as well as over the quality of materials used, in that branch of the works which deals with chemical explosives.

SANDHURST.

F. A. ABEL.

V. D. MAJENDIE, *Colonel,*
Her Majesty's Chief Inspector of Explosives.

F. T. LLOYD, *Deputy Adjutant-General,*
Royal Artillery.

R. H. BRADE,
Secretary.

12*th July*, 1894.

LIST OF WITNESSES.

Date of examination.	Name.	Page of evidence.
16th May, 1894 ..	Mr. J. M. Thomson, Manager and Chemist	1 to 4, 12
„ ..	Mr. W. T. Thomson, Chemist	4 to 6
„ ..	C. W. Pegram, assistant proof master	6
„ ..	J. W. Strange, danger house workman	7 to 8
„ ..	F. Bradley, labourer	8
„ ..	F. G. Coleman, danger house workman..	9
„ ..	W. Taylor, plumber	9 to 10
„ ..	E. Jackson, Chief Fireman	10
„ ..	E. Pyle, plumber	10
„ ..	G. W. Dellar, danger house workman	11
„ ..	W. Woodroffe, carpenter	11
„ ..	J. H. Player, carpenter	11
„ ..	J. Gray, bricklayer	12
18th May, 1894 ..	Dr. Anderson, Director-General of Ordnance Factories ..	12 to 14
„ ..	Colonel W. McClintock, Superintendent of Royal Gunpowder Factory.	14 to 18
„ ..	Colonel M. T. Sale, Superintendent, Building Works Department.	18 to 19
„ ..	Captain Huleatt, Assistant Superintendent, Building Works Department.	18 to 19
„ ..	Dr. A. Dupré, F.R.S., Chemical Adviser to Home Office ..	19 to 22
„ ..	Dr. W. Kellner, Chemist to War Department	22 to 23
25th May, 1894 ..	Mr. George McRoberts	23 to 26
„ ..	Mr. Oscar Guttmann	26 to 29
„ ..	Mr. C. O. Lundholm	29 to 31
„ ..	Sir Benjamin Baker, K.C.M.G., &c.	31 to 33
„ ..	Mr. J. M. Thomson (re-examined)	33 to 34

Enquiry into the Explosion of 7th May, 1894, at the Nitro-glycerine Factory, Waltham Abbey.

WALTHAM.

WEDNESDAY, 16TH MAY, 1894.

Present

Sir F. A. ABEL, Bart., F.R.S. (*in the chair*).
Colonel V. D. MAJENDIE, C.B.

Mr. R. H. BRADE, *Secretary*.

Mr. JAMES MILN THOMSON, *examined*.

1. *The Chairman.* Will you please state what position you hold in the Royal Gunpowder Factory?—I am the manager of the cordite factory.

2. Were you in the factory at the time of the explosion on Monday last, the 7th of May?—No, I was on leave at Bournemouth, and, therefore, I can only speak of my own knowledge to the after effects of the explosion.

3. Have you had a long experience in the manufacture of nitro-glycerine?—Yes, I was at Nobel's factory for nine years, and I have been about four years here.

4. Were you at Nobel's factory at the time their plant was rearranged?—I was there when No. 2 hill was erected and also while they were arranging the little hill.

5. Was Mr. McRoberts the manager then?—Yes.

6. Were any modifications made in the arrangement of the later nitro-glycerine works as compared with the former works?—Only the A and B were in one; that is to say, the nitrating house and the separating house were one instead of being separate houses.

7. *Colonel Majendie.* But nitrating and separating were not going on in the same house at the same time?—No.

8. *The Chairman.* Was B erected before the nitro-glycerine works here were put up?—Yes, it was erected before I left.

9. What was the condition of things here, with regard to the nitro-glycerine works, when you were first appointed?—The houses were erected and part of the German plant was lying in the houses, but the levels were not proper; some mistake had been made about where the nitro-glycerine came out.

10. Did that necessitate any alteration being made in the buttresses and traverses that had been already erected?—It necessitated raising up part of the nitrating house.

11. But, so far as the washing house was concerned, no alteration was made as regards the house itself or its protection?—No.

12. What occurred when you came; did you modify the nitro-glycerine plant?—Yes, the German plant had, seemingly, received very bad usage, it was broken; I did not like the way it was done at all; the coils went through the side of the apparatus, and some of the other details were unsatisfactory.

13. Then, do I understand that the apparatus was not so much repaired as reconstructed?—Everything was reconstructed, except the separating tank.

14. And in that reconstruction, did you follow the plan adopted at Ardeer?—Yes, it was almost identical with that.

15. While the reconstruction was in course of being carried out you had the advice of Mr. McRoberts, had you not?—Yes, if I had any difficulty I referred to him; he looked at all the plans I drew out, and he approved of them. He was here when the Explosives Committee came down.

16. Have you thought over the subject of this accident?—Yes.

17. Have you, in your own mind, arrived at anything like a conclusion as to the cause?—No.

18. Is it a fact that the plumbers had been engaged on the plant on the Saturday in the week preceding the explosion, and that the Monday on which the explosion occurred was the first time of working, after the alterations had been made?—Yes.

19. What officials had to satisfy themselves that the alterations made were correct and proper?—Both the chemist in charge, Mr. Bennie, and the foreman, Mr. Suckling: they had to look at the plant when all repairs were finished, and another rule is that the foreman must examine the plant every morning before the work is started, in order to see that the pipes and everything are all in proper order. Mr. Suckling was the foreman, whose duty it was to do that. The repairs on that occasion consisted of new air pipes being put in to replace others, which had become worn with time.

20. *Colonel Majendie.* Was there anything done which could have in any way affected the free access of the injected air?—No, nothing whatever, and at the stage at which the treatment was, even supposing the air had fallen short, I cannot see how that could have affected it.

21. Do you mean that the material had arrived at such a stage that it might have remained there without any air agitation?—Yes.

22. How do you know that; from what you have heard?—Yes, from what Strange has said, and he was there only seven minutes before the explosion.

23. *The Chairman.* I understand there were two batches of nitro-glycerine in the house at the time, one of which had been thoroughly washed?—One was within a quarter of an hour of being thoroughly finished, but the other was at its second washing.

24. With regard to the nitro-glycerine store, what, to the best of your knowledge, was in the house at the time of the explosion besides nitro-glycerine?—Nothing, so far as I am aware. One of the tanks was a square tank, into which we washed the gutter after a day's work.

25. Would there be any accumulation of nitro-glycerine in that wash water from the gutter?—Yes.

26. Would it be pure nitro-glycerine, and thoroughly washed like the other?—Yes, and it was taken back to the washing house.

27. *Colonel Majendie.* Why was that?—Because it was wet.

28. Not because it was impure?—No, it had to be filtered because there was water in it.

29. Where was the filtering done?—In the washing house.

30. Then the operations in the washing house were really two, washing and filtering?—Yes.

31. May we take it that nothing left that house until it was washed or filtered?—Washed and filtered.

32. *The Chairman.* Was all the nitro-glycerine filtered?—Yes, all that went down to the store house.

33. *Colonel Majendie.* What would there be that was not filtered?—Only a little flocculent matter on the top, that was washed out and put back into the washing tank if it appeared clean.

34. *The Chairman.* Was that store house simply a store house?—There was a man there weighing out the nitro-glycerine for guncotton.

35. *Colonel Majendie.* Was it a mixing house as well?—Hardly that, because it was carried away to another house for mixing.

36. *The Chairman.* Then was that weighing out the only operation carried on in the store?—Yes.

37. *Colonel Majendie.* I understand that, at the time of the explosion, there was no person in the store. Can you say if that was the case?—I cannot hear of anyone being there.

38. The only men missing are the four who were killed?—Yes.

39. Will you give us their names and say what their duties were, generally?—William Bennie; he was the principal chemist in charge of the nitro-glycerine factory under me. George Suckling; he was foreman in the nitro-glycerine factory under Mr. Bennie, and his duties were to superintend the whole hill under Mr. Bennie's directions.

40. Was Suckling primarily responsible for the proper working condition of the plant before work was started?—Yes, but not for the whole of the time, of course; if anything out of the ordinary happened, either Mr. Bennie or Mr. Suckling would be called.

41. But you expected Mr. Suckling to visit the whole of the plant before work was started?—Yes, it is stated in the rules that he should do that, and I know he did it.

42. Can you hand in a copy of the rules affecting the houses of which we are speaking?—Yes [handing in a copy of the same, Appendix IV.]. They are practically Nobel's rules slightly altered. Another man killed was William Ingram, foreman plumber. His duties were to examine all the nitro-glycerine plant each week after all the operations were finished, and to give me a list of repairs which he considered ought to be carried out.

43. *The Chairman.* Was he responsible for the proper execution of those repairs?—Yes.

44. *Colonel Majendie.* It says in these rules that the foreman is to accompany the plumber on the weekly inspection; when did that weekly inspection take place?—On Friday.

45. *The Chairman.* Can you say what business brought him here at the time of the explosion?—Seeing that he asked for Mr. Suckling, the only thing I can think of is, that he wanted to see whether the air-pipes were working properly; he visited the nitrating house and asked for Mr. Suckling just before going to the other house. The last of the four men killed was George Frost; he was a danger-house man, actually working on the nitro-glycerine; he was formerly in the Gunpowder Factory, and he came here two years ago.

46. *Colonel Majendie.* Was he a good man?—Yes, one of the best we had on the hill.

47. Do you know, or have you any means of knowing, where these four men were when the accident occurred?—I have no doubt that Mr. Ingram was standing at the foot of the steps, because most of his remains were found on the steps.

48. Do you think he was inside the traverse?—Yes, I think so, judging from the position of the steps where his remains were found.

49. Were his remains recognizable?—Yes. From what I have been told, I presume that Bennie and Suckling were on the same side of the house, that is, the west side facing the door. [The witness explained the position to the Committee by means of the plan, Appendix II.] Frost's remains, I understand, were found all over the place, from which I infer that he was at work at what was practically the focus of the explosion. I also understand that a man's hand was found on the top of a piece of a tank, and I think that must have been Frost's hand.

50. When did you actually leave the factory?—On Saturday at 12 o'clock.

51. When were you last in this house?—On Thursday, when it was working; it did not do any work on Friday or Saturday, because the repairs were being done on those days.

52. When you saw the house working on Thursday, was it working to your entire satisfaction?—Except that the separation from the washing water was slow.

53. Why?—I cannot tell why; I have had the same thing happen at Nobel's, and there we put it down to the glycerine.

54. With regard to the materials, were you at work on any new batches of either acids or glycerine?—We have been on the same glycerine for some time; the acids we get in each week, but they are all tested.

55. Can you say whether or no the materials used at the time of the explosion were similar to what had been used in previously made batches of nitro-glycerine?—I should say they were the same.

56. With regard to the glycerine used, can you speak confidently as to that?—Yes, it was very good glycerine, except that it separated badly in the washing tank.

57. *The Chairman.* Had you previously noticed this slowness of separation?—Yes, for about a month or so.

58. Then that would be all one batch supplied under one contract?—Yes.

59. *Colonel Majendie.* Did the circumstance of this slow separation cause any anxiety in your mind?—No, not in the least, except in so far as time was concerned, and then it was a nuisance.

60. When that happened at Ardeer, was it accompanied by any accident?—No.

61. *The Chairman.* Did this slow separation affect the temperature at all?—No.

62. *Colonel Majendie.* Was the washing arrangement carried out here in much the same way as that followed at Ardeer?—Yes, it was practically the same.

63. I understand that the wash water and the soda water is drawn off by means of a lead skimmer with an indiarubber pipe leading out at the bottom?—Yes.

64. Had that been in any way altered, or dealt with, in the repairs that were carried out just before the explosion?—I think the plumber fitted a new indiarubber pipe on to the skimmer.

65. The skimmer was suspended, was it not?—Yes.

66. Have you ever known the supports from which the skimmer was suspended to give way, either here or elsewhere?—No.

67. Skimmers were not originally employed at Ardeer, were they?—No.

68. Were they looked upon there as improvements?—Yes, they were considered so.

69. Had you worked skimmers here for several years?—Yes.

70. And had you come to consider them satisfactory?—Yes.

71. May we take it that the arrangement for washing is, in your judgment, a satisfactory arrangement?—Yes, I have never felt any anxiety in regard to it.

72. Taking generally your experience of nitro-glycerine factories, would you say that the washing houses are, on the whole, safe houses?—Yes, I have never dreamed of there being any danger in a washing house except in a case of frost or by letting fall a beaker of nitro-glycerine; our floors were solid floors, and I feared them more than the floors at Ardeer, which were of sand, and I therefore introduced gutta-percha beakers here.

73. What were they made of before?—Glass.

74. The floors remaining the same?—Yes, a wood floor with a lead covering. I ought to say, however, that there was one small beaker of glass used, and that was for pouring the stuff into the gutta-percha bottles.

75. Was that in the house at the time of this explosion?—Yes.

76. But I presume that would only be used for the purpose of taking samples?—Yes.

77. The nitro-glycerine brought into the house would consist of that which came down from the separating house, and that which from time to time was brought back from the store for washing?—Yes.

78. And all that nitro-glycerine was presumably pure?—Yes.

79. *The Chairman.* Except as regards matter in suspension?—Yes, and when we found that, we filtered it through flannel.

80. *Colonel Majendie.* Did you filter the refuse nitro-glycerine, if I may so call it, in the wash tanks?—No, we filtered it down in the washing shed, and then carried it up in buckets.

81. *The Chairman.* What was the temperature of the water used?—About 70 degrees centigrade (158 degrees Fahrenheit), as it was run in, but when the charge was in the tank it was not above 50 degrees centigrade (122 degrees Fahrenheit).

82. How was the 50 degrees insured?—By taking the temperatures when they are putting on any fresh washing; a man stands with a thermometer in his hand and they run in hot and cold until it gets to 48 degrees (118 degrees Fahrenheit), and that is really the maximum used; the carbonate of soda solution is prepared in the nitrating house, and it starts at about 80 to 85 degrees, but it loses a great deal in the gutters. Many tests showed the temperature of the soda solution in the washing tank, before running in the charge of nitro-glycerine, to be about 50 degrees, and the inflow of nitro-glycerine immediately brought the temperature much below that.

83. *Colonel Majendie.* It says in the rules that the material shall be tested before it is allowed to run into the filtering tanks?—Yes, Mr. Bennie did that.

84. Where did he do it?—In the washing house.

85. What test did he apply?—Litmus paper.

86. Where was the test for final purification applied?—In the nitro-glycerine laboratory.

87. The material being taken from the filtering tank in the washing house?—Yes.

88. It would not leave that house for the store until it had passed that test?—It would be run down, but it would not be used.

89. Have you at any time had to re-wash any material that had been passed into the store tank?—No, not since I have been here.

90. Do you therefore feel confident that the material present in that house, on the day of the explosion, was pure?—Yes, exceptionally pure, because the heat test applied to nitro-glycerine was very severe, it was 15 minutes at 180 degrees Fahrenheit

91. *The Chairman.* Was that more severe than the test at Ardeer?—Yes, there it was only 15 minutes at 160 degrees.

92. *Colonel Majendie.* When had the last of the nitro-glycerine in the store been passed into the store? was some run down on Thursday?—Yes. The last was run down about thirty-five minutes before the explosion, but some was run down on Friday morning.

93. Had that been tested?—Yes.

94. *The Chairman.* You ran some down into the store tanks before it was tested?—Yes.

95. And there it was mixed with nitro-glycerine that had been tested?—No, we had two tanks in the store, one was kept for the nitro-glycerine that was being used and the other was kept for new nitro-glycerine.

96. Was more than one batch ever run in at the same time?—That might have happened, but it was not usual.

97. Would you not consider it very desirable that there should not be more than one batch at one time?—Under such a system as that we should have required a large number of large tanks.

98. Do you apply the same test to each individual charge?—Yes.

99. Suppose one of them is less pure than others, it would become mixed with the others?—Yes, but then we should re-wash the whole thing.

100. *Colonel Majendie.* Was the store one of the improvements at Ardeer?—No, there was no store at Ardeer, they used the materials for dynamite straight away, and they tested it as nitro-glycerine from a sample the next day.

101. Do you mean that they had it made up into dynamite before they were absolutely sure that it was pure?—Yes, as a matter of fact they did not test the nitro-glycerine at all until it was made into dynamite; so that it was extracted from dynamite the next day.

102. That, I suppose, was because they felt confident that their system of manufacture would yield good results?—Yes.

103. During your stay there had they to re-make any dynamite?—No, never.

104. Therefore their confidence was justified?—Yes.

105. What was the minimum time?—15 minutes.

106. According to this list I see that the times vary, 18 minutes, 21 minutes, 23 minutes, but all at a temperature of 180 degrees Fahrenheit?—Yes.

107. Those refer apparently to the last lots that had gone in except the two batches which had gone in on the morning of the explosion?—Yes.

108. And it would be something wholly outside your experience if those two batches had been different from the others?—Yes, it would. I think if you look at the beginning of that book, you will find that the test was at 160 degrees, but the washing is really better now than it was then, because we have a better supply of air.

109. I see that on the 29th November 1892, you appear to have gone up to 180 degrees fahrenheit, may we take it that you have kept at that increased temperature ever since?—Yes.

110. Would you say that nitro-glycerine which would stand 15 minutes of that test, would be a purer article than nitro-glycerine which stood for very much longer periods of time at 160 degrees?—Yes, certainly.

111. Was the increase of temperature one of the results in the improvements of the air supply?—I believe it was; we had very small engines at first and sometimes we ran short of air, but since we have had the new engines, the nitro-glycerine has been better purified.

112. Have you known of any failure lately in the air supply?—No, not since we had the new engines put in in 1892.

113. Have there been any complaints made to you about the air supply being insufficient?—No, nothing, except one day a man came along and said he could not supply steam for both the engine and the guncotton, and I said he must stop the guncotton.

114. How long ago was that?—About a month ago, I think.

115. *The Chairman.* When the air failed you, or when the temperature rose, had you anything approaching a dangerous state of things?—None whatever in the washing, it only took longer to wash.

116. *Colonel Majendie.* How much was there in each of these houses at the time of the explosion?—From what I can gather, I think the two charges in the washing house amounted to about 1,500 pounds.

117. Was there anything in the filtering tank?—No, I think not. I understand the charge had all been run down.

118. With regard to the mixing house, or store, can you say how much was there?—Speaking roughly, I think there was about 2,200 pounds there in the two tanks.

119. This plan (Appendix III.) shows two houses separated by traverses, but inclosed, so to speak, in one pit; were both those houses in use?—No, only the eastern one, the other one had no tanks in it, and, therefore, could not be used.

120. The connection between the washing tanks in the washing house and the store was, I understand, effected by means of gutters enclosed in wooden tunnels?—Yes.

121. They went a certain distance together and then diverted respectively to the houses?—Yes; but the easterly arm was the only one in use.

122. And no nitro-glycerine had been in the other one at all?—No, because there was no gutter there.

123. Therefore it would have been impossible for any person working on that branch or arm of the tunnel to have made any explosion there?—I do not see how he could, because it had not been used for nitro-glycerine.

124. With regard to the general conditions of the gutters, was the fall satisfactory?—The gutter ran down fairly well, but it was not a good fall.

125. Would you have liked the fall to have been greater?—Yes.

126. Was there any accumulation of nitro-glycerine about here?—It did lie sometimes in the gutters until it was washed down.

127. Was there any guncotton kept in that house?—No.

128. *The Chairman.* Was there a chance of any being distributed about the floor?—The whole floor was left quite wet.

129. *Colonel Majendie.* When the house was left, was it locked up?—Yes,

130. Was there a gate in the traverse?—Yes, a locked iron gate, as well as a locked door to the house.

131. Could anybody have access to the house except through the door; that is to say, could a man get through the window?—Not so far as I am aware of; there are fastenings on the windows.

132. *The Chairman.* Anyone from the outside could get into the tunnel, could he not?—Not very well, unless he were inside the traverse; the door was barred from the inside.

133. *Colonel Majendie.* What system of inspection were the men working in this house subjected to in regard to being searched; where did they come in?—At the gate at the foot of Quinton Hill, and they were stopped by the police and searched each day.

134. Where did they change?—In the changing house just down here, outside the guncotton house.

135. What did they change?—Everything excepting their under clothing; they had to put on a pair of red trowsers and a jacket.

136. Might they put them on over their own waistcoats?—They were not allowed to keep their own waistcoats on unless those waistcoats were without pockets.

137. Whose business would it be to see that they had no pockets in them?—The foreman of the hill, Mr. Suckling.

138. Did he do that?—I understand he did.

139. Did he ever find a man with pockets?—Not that I am aware of, but I know that he caused a man to repair the lining of his waistcoat, and to leave off a belt with a steel catch. Also he caused all the men to remove all steel or iron from their braces.

140. With regard to the repairs, I suppose, when they are going on, a house is no longer a danger building?—No, it is thrown out of danger then.

141. And I understand it would not be taken into use again until somebody in authority said it might be taken into use again?—That is so.

142. Were the repairs ordered by one officer and certified as completed by another?—Yes, here are some certificates showing how, and by whom, repairs were ordered, carried out, and certified as completed. [The witness produced some forms showing the procedure adopted where repairs had to be executed. The forms showed that, when the repairs were finished, Mr. Ingram signed them to show that the work was completed, they were initialed by Mr. Hodgson, the Chief Engineer, and then sent on to the witness, who also initialed them to show that the repairs were completed, and then finally sent them on to the Superintendent, who also marked them to show that he had noted the facts.]

143. *The Chairman.* With regard to these certificates, there was beyond them no formal proofs supplied to you that the foreman had done his duty of inspection?—No, except that, if anything had not been done properly, the certificate would not have come on.

144. *Colonel Majendie.* But if we asked you if you knew how the work was done, what would you say?—I should say that neither the chemist nor the foreman would neglect their work.

145. You would rely upon them for doing that, would you?—Yes, and I should also rely upon the plumber as a man of experience.

146. But the plumber who did the work would not be the head plumber?—That is so, but the chief plumber would inspect the work.

147. But looking to the certificates rendered, you are not able to say as a fact that the chief plumber was there after the work was done?—No.

(*The witness withdrew.*)

Mr. William Thomas Thomson, *examined.*

148. *The Chairman.* What is your position in the Royal Gunpowder Factory at Waltham?—I am chemist in the guncotton factory.

149. Where were you at the time of the explosion?—In No. 1 cordite press house, which is about 300 yards from where the other houses stood. As Mr. James Thomson was away, I was managing the factory that day. It was only about seven or eight weeks ago that I was changed from the nitro-glycerine factory to the guncotton factory.

150. Will you state what you saw and heard at the time of the explosion?—Being inside the house I did not see anything; the first thing that happened was the glass came tumbling down, and then I heard the explo-

sion. At first there was a rumbling, something like the noise made by a train coming into a station, then there was a terrific noise.

151. *Colonel Majendie.* The noise was not marked in its commencement by an explosion?—No.

152. So that the greatest noise was at the end?—Yes.

153. Were you injured at all?—Immediately I heard the noise I ran out of the press house, and when I got outside I was struck on the leg by something.

154. When you sufficiently recovered yourself what did you do?—I went on towards the washing house and I met one of the nitro-glycerine men, and I asked him for Mr. Bennie, the chemist.

155. *The Chairman.* Whereabouts was that nitro-glycerine man?—He was coming up the hill from the shifting-room. Then I asked for Mr. Suckling, but he did not turn up. I then saw one of the men coming out of the nitrating house and he told me there was a charge in there, so I went in with a man and let the charge down into the drowning tank, where we washed it with several waters.

156. *Colonel Majendie.* Can you change your waters easily in the drowning tank?—Yes, very easily.

157. *The Chairman.* Had you that morning been into the nitro-glycerine store?—Yes, twice that day, once with the superintendent, and four gentlemen, one of whom was Mr. Anderson, from Messrs. Easton & Anderson's, and one was Mr. Lundholm, from Ardeer. I visited the nitrating house and the washing house, then I went down to the nitro-glycerine store.

158. When were you last in the washing house?—At about 2 o'clock, the explosion was a little after 4.

159. What were the men engaged in doing when you were there?—They were washing the second and third charges, I think.

160. And what presumably happened after you left the washing house?—They filtered the second charge and sent it down to the store, and then the fourth charge would be brought in. The third charge was finished with the third washing, and the fourth charge was in the second washing. Judging by the time, I can imagine that that was what was done.

161. When you visited the washing house, was there any other nitro-glycerine there besides the two charges?—No.

162. No refuse nitro-glycerine?—No.

163. There was occasionally nitro-glycerine refuse in that house, was there not?—No, not unless they were bringing in a charge from the nitrating house, and then we should carry it up from the shed in buckets and take it into the house and mix it with the charge at once; we never had any standing there, that was not allowed.

164. *Colonel Majendie.* Was anything in the filtering tank when you were there?—No, the filter was empty, the first charge had been sent down.

165. Were you aware that some repairs had been done to the house on Saturday?—No, I was not aware of that.

166. Have you heard any remarks made in regard to the air supply?—No, the supply of air seemed to be very good when I was there; I always looked at the air pressures and at that time I saw that they were working well, with a pressure of between 40 lb. and 50 lb.

167. Is that a good pressure?—We think it a good pressure, we aim at 50 lb.

168. What would be bad pressure?—We never want to get below 30 lb.

169. The day of the explosion was a cold day, but not cold enough, I presume, to freeze nitro-glycerine?—No, the temperature of the atmosphere was about 50 degrees, I think.

170. I understand that when they run away water, it is done, first of all, from the bottom, through an indiarubber tube, which comes from the skimmer down to the tap below?—Yes.

171. And there is another tap for the nitro-glycerine at the bottom of the tank?—Yes.

172. Is that an earthenware tap?—Yes, put in with cement.

173. Has that tap ever given you any trouble in the way of working stiffly?—No, but on one occasion, in the bad winter of two years ago, I had to put hot cloths on one because it was stiff.

174. It would have been dangerous to force that would it not?—Yes.

175. *The Chairman.* Is there any probability of a tap having been in that condition on the day of the explosion?—No, I think the atmosphere inside the house must have been at about 60 degrees, because it was warmer inside than out.

176. What is the highest temperature at which the soda-water is allowed to run in?—It runs down the gutter and alters according to the kind of day. I should say the highest temperature would be about 50 degrees centigrade; the nitro-glycerine immediately cools down and the highest temperature in the first washing is from 30 degrees to 35 degrees.

177. *Colonel Majendie.* With regard to the tap, is there anything which, independently of the nitro-glycerine freezing, would cause the tap to work stiffly or awkwardly?—I have never seen anything.

178. Were you ever at Ardeer?—No.

179. Then you are now referring to your experience here?—Yes, I have been here about three years.

180. Have any complaints been made to you by any of the men as to difficulties with the taps?—No, I have never known of anything except the one occasion to which I have just referred.

181. Have you ever had to check any of the men for attempting to force the taps?—No, they were all very steady men, and Frost was a steady man.

182. Did you see him that day?—No, he came on at half-past 2.

183. Was he a sober man?—He was a teetotaler.

184. When you went down to the store from the washing house was there anyone in the store?—Coleman was there weighing out nitro-glycerine; Cleverly was also there; that was between 12 and 1.

185. When the store was left without anybody, was it always locked up?—Yes, both door and gate.

186. Would it be easy for anybody to have access to that store without a key?—They might get over the gate into the pit, but they could not get into the store without a key.

187. Was the key only just turned in the lock, and left, or was it taken away?—I believe Coleman took the key away and put it in the door of the washing house a quarter of an hour before the explosion.

188. Was the key in charge of the same man on the Saturday before the explosion?—No, the men change about; Coleman was the man in charge for that week. While the man is weighing out the nitro-glycerine the key is left in the door, but when the man leaves he locks the door and takes the key and puts it in the door of the washing house and leaves it there, because the same key locks both doors.

189. Is not the washing house locked when they are not at work?—Yes, and the policeman makes a report if he finds the doors unlocked or the keys left in the lock. During the day the key is either in the door of the store, or if they are not at work there then it is in the door of the washing house. At night time the places were locked up by Suckling and he kept the key in his office in the tower.

190. Could anybody have access to the key there?—No, it is always locked up.

191. Then it would not be easy for anybody to get into the store when there was no one at work there?—The only way would be to pick the lock. There is only one key for the whole hill.

192. From what you actually saw of the effect of the explosion, did you notice whether there was any column of débris and stuff rising up from the blown-up house?—I saw it falling.

193. Can you, from what you saw, say which house went first?—I can only speak of the débris that I saw falling, and that was coming from the wash house; in fact, I thought it was only the wash house that had gone.

194. Were you in a position to see the store from where you were?—Yes.

195. Do you think from that that the débris had

fallen before you noticed the other?—Yes, because I cannot remember seeing anything from the store at all, the stuff that I saw was coming from the side where the washing house stood.

196. I understand that you had charge of the nitro-glycerine department at one time?—Yes.

197. Had you ever at any time to reject nitro-glycerine as being impure?—The lowest heat test that ever I got was 16 minutes at 180 degrees Fahrenheit.

198. Therefore you would be very much surprised if you heard that there had been any impure nitro-glycerine in the store, would you not?—Yes.

199. *The Chairman.* How soon after a batch had been finished did you test the nitro-glycerine?—It was tested before it was made into cordite.

200. But not before it passes to the store?—No, we could not work it in that way.

201. *Colonel Majendie.* In the store house it would be waiting till the test had been passed?—Yes, in the tanks.

202. But one contained passed stuff?—Yes.

203. *The Chairman.* And the other one contained batches of some that had not been passed?—Never more than two.

204. Would there be actually more than two batches at any time in that tank?—There might be a little in the bottom that had been passed.

205. And the unpassed would be mixed with that?—Yes, but we tried to empty the tank before we put any unpassed nitro-glycerine in.

206. *Colonel Majendie.* Have you in your own mind been able to arrive at any conclusion as to the cause of this accident?—No.

207. *The Chairman.* Have you thought over everything connected with the washing house?—I always thought the washing house a safe house, but I looked upon the nitrating house as a suspicious house.

208. *Colonel Majendie.* Would you look with less suspicion upon the store house than upon the washing house?—Yes, because there was no practical work done there.

209. There was pure, or presumably pure, nitro-glycerine in the two tanks in the store house?—Yes.

210. Was there anything else in the house?—No.

211. Was there any guncotton there?—No, it was never allowed to be there unless the men were there.

212. *The Chairman.* There was a tank there to receive the refuse nitro-glycerine?—That was cleaned out on the Saturday.

213. *Colonel Majendie.* You know that?—Yes, we always washed it out on Saturday.

214. Was there anything in that tank on the Monday when you were there?—I did not look.

215. Was it a covered tank?—No, it was an open one.

216. Have you ever known of a skimmer falling down, or coming down with a run, or in any way coming into violent contact with anything?—No.

217. Was there any risk of a skimmer doing that?—No, I think not.

218. So far as I understand your evidence upon the question of priority of explosion, I gather that you think that of the two, the storehouse went first?—I can only say that from what I saw of the falling débris, I have no certain opinion upon the point.

(*The witness withdrew.*)

Mr. Christopher William Pegram, *examined.*

219. *The Chairman.* What is the nature of your employment in the Royal Gunpowder Factory at Waltham?—I am Assistant Proofmaster in the Gunpowder Works.

220. Where are you stationed during the day?—On the range to the west of the nitro-glycerine buildings.

221. Where were you at the time of the explosion?—When the first one went off I was inside the armoury.

222. Did you see anything?—Not of the first one, I only heard it. I then went to my door, which faces the nitro-glycerine houses, and when I got there I saw a lot of black stuff and smoke in the air, and at the same time there was another explosion.

223. *Colonel Majendie.* Which was the louder?—I could not say.

224. But you saw two columns?—When I got out one was up, and while I was looking at it the other went up.

225. Was the one in the air more to your right, or to your left?—From the way I was looking it was more to my right. [The witness then explained to the Committee, by means of the plan, Appendix I., the position of the range with reference to the nitro-glycerine houses.]

226. *The Chairman.* What were you doing at the time of the explosion?—I was standing by a little table close to the door.

227. Had there been any firing during that day?—No. The whole thing was so instantaneous that before the rumbling of the one explosion had ceased, the other one occurred.

228. *Colonel Majendie.* As I understand it you have no doubt whatever that there was an interval, and that one explosion succeeded the other, and you know which went first?—I know which went first, for I saw it in the air, and then I saw the other come up.

229. But the débris of both were in the air at the same time?—Yes, when I got to the door I had to look in *this* direction (*i.e.*, to my right) to see the débris of the first one, it looked like a large balloon, and while I was looking at it the other went up.

230. Can you give us any further information upon the subject of this explosion?—No.

231. Was there any firing going on at the Enfield ranges?—I did not notice any.

232. Was there anybody with you in the building you speak of?—No, but there were two men in the butt throwing shot out.

233. Did they see anything?—They only saw the smoke.

234. Did they hear anything?—Yes.

235. Did they hear two explosions?—I cannot say.

236. Have you asked them any questions upon the subject?—No.

237. Did you come up here after the accident?—Yes.

238. But you saw nothing beyond what you have already stated which will help us in any way?—No.

(*The witness withdrew.*)

Mr James William Strange, *examined.*

239. *The Chairman.* What is the nature of your employment in the Royal Gunpowder Factory at Waltham?—I am a danger-house man in the nitro-glycerine factory.

240. How long have you been employed in that capacity?—I have been on the hill about 12 months last March; I was in the powder factory and in several other branches before I came here.

241. In which house were you principally employed?—We have to take turns round all the houses.

242. Where were you at work at the day of the explosion?—I was in the washing house.

243. And how long had you left it before the explosion occurred?—From 8 to 10 minutes.

244. Where were you when it actually occurred?—In the shifting room over the way.

245. *Colonel Majendie.* Then you could not see the washing house from where you stood at that time?—No.

246. *The Chairman.* What did you hear?—I heard one report, then a sort of rumbling noise, and then another report.

247. You did not hear two reports?—Yes, but they were very close together.

248. *Colonel Majendie.* Which was the louder of the two?—I could not say.

249. Which sounded the further off?—I could not say.

250. *The Chairman.* How long had you been at work in the washing house that day?—Since half-past 6 in the morning. The charges came in in the usual way, and they were washed; two had been washed and sent away.

251. *Colonel Majendie.* When did you get the first one in?—About 10 o'clock in the morning, or it might have been a little before, I cannot say for certain; another came soon after that. Those two charges I, myself, ran down to the store, and then the third charge came in, and when I left the house that had just shut off the third washing, and the fourth charge had just started the second washing.

252. Therefore it would have been more than half washed, but not completed, at the time of the explosion?—That is so.

253. *The Chairman.* Who relieved you?—Frost; he took up the same work that I was doing.

254. What was he probably doing at the time of the explosion?—When I came out he was running the third soda off the third charge, and, as the charges had been rather tiresome in settling lately, that is about what he would have been doing, running it off by means of the skimmer and through the tube with the tap at the bottom.

255. Do you ever remember the skimmer coming down rather sharply on to the nitro-glycerine?—Never, while I have been there.

256. Have you ever heard of its coming down in that way?—I have never heard of the cord breaking.

257. Have you ever known it to slip?—I have had it slip, but not to touch the glycerine.

258. *Colonel Majendie.* How was the skimmer secured?—It was suspended from the ceiling by means of a pulley.

259. *The Chairman.* Did it entirely depend upon you whether it came down slowly or quickly?—Yes; when running soda water off it would, because we held the cord, and lowered it down as we wanted it.

260. Then if, by any chance, you let it go, it would come down with a run?—Yes, if we were not careful, it would.

261. *Colonel Majendie.* That would be likely to happen as the water was being run off, because the nitro-glycerine would then be exposed?—Yes.

262. And, if it fell while water was in, it would fall on the water, but, if there were no water there, it would fall on the nitro-glycerine?—Yes.

263. Did the skimmer swing about much?—No, it was pretty tight.

264. Did it ever touch the sides of the tank?—Not when it was suspended.

265. *The Chairman.* What would a skimmer weigh?—It is rather heavy, but I could not state the weight.

266. *Colonel Majendie.* According to what you say, there would, apparently, be no need to use the nitro-glycerine tap at all at the time of the explosion, would there?—No, I think not.

267. If the man had used the tap, then one charge would, apparently, have had one washing too little, and one would have had two washings too little?—Yes.

268. Did the taps work satisfactorily?—Yes; but, occasionally, we greased them with a little vaseline.

269. When you ran the charges off that day, did they work all right?—Yes, they worked in the usual manner.

270. Was the air supply good?—Yes, all the time I was there.

271. Had not some repairs been carried out on the previous Saturday?—Yes, some new air pipes had been put in.

272. Were they on the Monday working as well as they ought to work?—Yes, I did not see any difference in them; of course Monday was my first day in for a little time, because, as I say, we take turns round.

273. Who told you to go to the house that morning?—Mr. Suckling.

274. Were the plumbers in the house when you got there?—No.

275. Was Mr. Ingram there?—I did not see him, I do not think I saw him at all on Monday.

276. He had not been to the house to look at the pipes while you were there?—Not that I can remember.

277. Did you see any of the plumbers there at all that day?—Pyle came to the door of the washing house.

278. *The Chairman.* When did you get to the washing house that morning?—At half past 6.

279. But the first charge did not come till about 10; what did you do in the meantime?—We have to go down to the filtering shed at the end of the factory and get some stuff out of the round tub there; the nitro-glycerine is taken from that round tub and put into the square tank and washed.

280. *Colonel Majendie.* How did you get the stuff out of the tub?—There is a sort of lead lip on the side of it, and we tip it up to run the stuff into the buckets. We put those buckets of stuff into the charges and another man and myself brought up two buckets at a time, as it was wanted. The buckets we used were wooden buckets with copper hoops.

281. And how did you work this stuff in the washing?—The soda is run in first, and then the charge and the nitro-glycerine, and then other soda on the top.

282. When you left the house was there any of what we may call refuse nitro-glycerine in the house, except in the charge?—No, there was none at all in the buckets.

283. You are quite sure there was none standing about?—None.

284. *The Chairman.* Is there any chance of that stuff being spilt on the floor?—If there is any spilt it is wiped up immediately with a cloth, that is one of the rules.

285. Where does that cloth go to?—It is kept on the side of the tank, we hang it on the bend that goes between the tanks; we also use that cloth to wipe the thermometers as we take them out.

286. *Colonel Majendie.* Did you go into the store at all that day?—Yes.

287. At what time?—I could not say the time, but it would be quite early, because it was before the charge

came into the washing house. We had to scrub out No. 1 tank.

288. Was the store usually kept locked?—It was always locked when nobody was there, we even locked it up if we went away for a short time.

289. And on going away, would the man take the key with him or leave it in the lock?—He would take the key away with him.

290. Did you ever see anybody in that house who had no business there?—No, not that I can remember.

291. Who would have business there?—Coleman and Cleverly.

292. Can you give us any idea as to which house exploded first?—No.

293. *The Chairman.* I suppose the cloth that you used for wiping the thermometers and other things sometimes got very wet?—Yes, and sometimes we washed it.

294 Where do you take it to wash it?—We dipped it into the warm water on the top, and then we sent the water to the wash-water settling-house.

295. *Colonel Majendie.* Did that always flow down to the other place?—Yes, down a sort of gutter.

296. Had the plumbers, who had been previously employed in that house, left any of their implements about?—I did not see any.

297. Was the house clean when you went into it on Monday morning?—Yes.

298. Did you wear "clean" boots for the washing place?—No, it is not a "clean" house, the nitroglycerine store is the only "clean" house on the hill.

299. *The Chairman.* You do get a little nitroglycerine on your boots sometimes, do you not?—I think not.

300. But, do you not sometimes splash the nitroglycerine out of the buckets and on to your boots when you are pouring it into the tanks?—Yes, perhaps so.

301. *Colonel Majendie.* What were the boots that you ordinarily wore in this house?—They are wooden pegged boots, specially provided for the purpose.

302. Do you put those boots on in the shifting room?—Yes.

303. But you walk from the shifting room to the house in those boots?—Yes. Of course if anybody comes with nailed boots there are some goloshes to put on.

304. You do not admit iron-nailed boots into the house, but you do not keep grit out?—That is so.

305. *The Chairman.* When the ground outside is wet your boots must get gritty?—Yes, but we clean them as much as we can on the mats.

306. *Colonel Majendie.* I understand that pockets in the clothing are not allowed in any part of the nitroglycerine hill?—That is so.

307. But you are allowed to wear your own waistcoats and underclothing?—Yes, if the pockets of the waistcoat are sewn up.

308. Who sees to that?—Nobody, but of course there is the rule up.

309. Is that rule always observed?—There is not one down here, up in the other place there was one, but we follow the same here.

310. Do the police search you?—Yes, when we come in at this gate.

311. Do the foremen of the house search you at all?—No.

(*The witness withdrew.*)

Mr. Frederick Bradley, *examined.*

312. *The Chairman.* What is the nature of your employment in the Royal Gunpowder Factory at Waltham?—I am a labourer on the proof range. I assist in doing what there is to do, principally in getting the batteries ready for experiments; I also attend to the Captain when he is there.

313. Were you at work at the time of the explosion?—Yes. I was inside the tin-shed as I call it. [The witness then explained to the Committee, by means of the plan (Appendix I.) his position at the time of the explosion.]

314. *Colonel Majendie.* Were you near Mr. Pegram at the time?—Yes.

315. Were you within speaking distance of each other?—Yes, we could have spoken to each other.

316. *The Chairman.* Did you hear the explosion?—Yes.

317. What did you hear?—I cannot exactly explain what it was, it was rather a critical moment just then.

318. Did you hear more than one explosion?—I cannot swear to that.

319. Did you see anything?—Yes, I saw lots of smoke before I came on the scene of the explosion, where I arrived about 10 minutes afterwards.

320. Then as far as you know there was one explosion?—I did not hear two and I cannot say that I did. I was in the tin-shed at the time and it rattled very much.

321. Did the rattle bring you out?—Yes, as soon as I could recover myself.

322. Did you hear any explosion when you got out?—I cannot say that I did, there was a terrible noise at the time and the shock was something.

323. Did Mr. Pegram say anything to you at the time?—I remember that he did say something, but I was rather upset at the time, because I had several relations about here.

324. *Colonel Majendie.* You saw a lot of smoke in the air?—Yes.

325. Did you see more than one column?—It existed in two places.

326. Can you say which was the first?—No, I cannot.

327. But you distinctly saw that there were two columns?—Yes, but owing to the confusion all round, we could hardly notice what did occur for a few seconds.

(*The witness withdrew.*)

Mr. Frederick George Coleman, *examined*

328. *The Chairman.* What is the nature of your employment in the Royal Gunpowder Factory at Waltham?—I am a danger-house man.

329. What duty were you doing on the day of the explosion?—I was in the store weighing out nitro-glycerine to be mixed with guncotton for cordite.

330. Had you done that work all the morning?—Yes.

331. Are you perfectly familiar with everything about the store?—Yes.

332. Was there anything there besides the two tanks of nitro-glycerine?—There was some stuff in the square tank where the washings are put in.

333. And nothing else?—No, nothing besides the two or three buckets of water that are always kept there.

334. Why are they kept there?—That is clean water for washing the flannels in.

335. *Colonel Majendie.* Was there any guncotton there?—There was none kept there.

336. Was there any there when you left?—No.

337. How does the guncotton get there?—It is brought to us.

338. Do you hand it out?—I simply weigh it and the cordite man takes it off the scale.

339. Were you in charge of the key of the store when you were there?—Yes.

340. How long had you left the store before the explosion occurred?—I left the store about 5 or 6 minutes to 4, which would be about ¼ hour before the explosion; I locked up the store all right and safe, and I took the key to the washing house and put it in the door. The same key answers for all the buildings on the hill.

341. *Colonel Majendie.* Did you lock the gate of the store?—Yes.

342. What did you do with that key?—The two keys are joined together by means of a ring.

343. Were you working in the store the week before the explosion?—No.

344. Who was?—I think it was a man named Ponders.

345. Where were you at the actual time of the explosion?—In the wash-up house.

346. What did you hear?—It was a funny sort of a sound and I did not know what it was at first, but I ran out and then I saw the stuff in the air.

347. Did you hear two explosions?—I heard one, then a sort of roll, then another.

348. Which was the louder?—The first, I think.

349. Could you see two columns of stuff rising up?—I could see only one from this side.

350. Then you do not know which house went first?—No.

351. Did you see anything in the store which you thought would be likely to blow up?—No, I saw nothing unusual there.

352. Have you worked in the washing house at all?—Yes, in my turn.

353. Have you ever seen anything in that house which could, in your judgment, be regarded as dangerous?—No, I have never noticed anything; they are very particular about not having things that are not required for the use of the house.

354. Have you ever made any complaint about anything being dangerous or wrong?—No.

355. Have you ever heard of any man making such a complaint?—No.

356. Did you think that a safe house as a rule?—It was the last house we should have thought was unsafe.

357. Did you ever see a skimmer come down with a run?—No, I never saw anything of that sort.

358. Would it knock against the sides of the tank?—It would ride on the stuff before it knocked.

359. It might knock on the sides if the soda-water were out and the stuff low down, might it not?—Yes.

360. Did you go into the washing house at all that day?—I only stood at the door, that was after I had left the store.

361. Was Frost there then?—Frost, Strange, and Mr. Bennie were all round the tank just then, Strange left just after I left.

362. But you saw Frost?—Yes.

363. Was he a steady man?—Yes, he was a very steady man, a total abstainer.

364. Did you see Mr. Ingram or Mr. Suckling?—No.

(*The witness withdrew.*)

Mr. William Taylor, *examined.*

365. *The Chairman.* What is the nature of your employment in the Royal Gunpowder Factory at Waltham?—I am a plumber employed in the nitro-glycerine and guncotton works, and I have to do the plumbing required in connection with the plant.

366. Were you employed in the washing house, previous to the explosion?—Yes; on the Saturday before I put some fresh air-pipes into both of the tanks in the washing house.

367. Do those air pipes require replacing pretty often?—No, not more often than perhaps once in three months. Whenever they show the slightest degree of wear, we at once renew them, but we never repair them. There are two air pipes in each tank. There are three air pipes in each washing tank.

368. When was the work finished?—On the Saturday just before 11 o'clock.

369. Was it inspected by anybody after its completion?—Yes, that work was always inspected by Mr. Suckling, the hill foreman.

370. Did he inspect that work on the Saturday, do you know?—I cannot say.

371. *Colonel Majendie.* What was the matter with the pipes that necessitated their renewal?—The air holes had got too large, that is the general fault.

372. And the pipes that you put in, had they air holes of the proper size?—I make the air holes myself of the size they ought to be.

373. Did you yourself see the pipes working?—Yes, I always try them before leaving.

374. Do you know whether Mr. Ingram had seen them?—I could not say. Mr. Ingram asked if I had finished the work, and I said yes.

375. When was that?—About 11 o'clock.

376. Did you see Mr. Ingram on Monday?—Yes.

377. Did you say anything to him about the work?—He asked whether everything was finished, and I said yes. I had put an indiarubber pipe into the skimmer at the same time.

378. Did Mr. Ingram go up to the house to examine the pipe?—I cannot say.

379. When you had the conversation with him where were you?—In the workshop.

380. Had you ever anything to do with the earthenware taps?—Yes, we put them all in.

381. Had you had anything to do with these at all?—No, they were all right.

382. Was there a good pressure of air?—Yes.

383. Did you test it on Saturday?—Not by the gauge, but I turned on the tap and felt all the holes to make sure that each hole was perfectly clear.

384. Where were you at the time of the explosion?—In the workshop.

385. Did you hear one or two explosions?—I heard a sort of rumbling noise like thunder.

386. Could you distinguish whether there were two or not?—No.

387. Can you tell us anything about the cause of the explosion?—I have not the slightest idea.

388. Was there anything in the house that was at all defective or unusual when you were there?—No.

389. Did you do work entirely by yourself or did anybody help you?—I did the actual work myself, but I had a labourer there to help me.

(*The witness withdrew.*)

Mr. Edward Jackson, *examined.*

390. *The Chairman.* What is the nature of your employment in the Royal Gunpowder Factory?—I am the chief fireman.

391. Where were you at the time of the explosion? I was at the other end of the works.

392. How soon did you get here?—About 8 minutes after the accident happened.

393. Did you hear anything of the explosion?—Yes, I heard a kind of rumbling sound and then one loud report.

394. *Colonel Majendie.* Did you superintend the search for the remains?—Yes, I found Mr. Bennie's leg just alongside *here* [pointing out the place on the plan], and he was identified by his sock. Suckling's leg was found not far off, but I did not find any other portions of his body to identify him by. Part of Ingram's trunk was found *there* [pointing out the place on the plan] as near as possible, and the other part we found on the steps about *here.* Frost's leg was found not far from Ingram's trunk, and a hand was found right over *here*, but the hand was not identified, it was just a hand and wrist.

395. They were all blown away rather to the east were they not?—Yes, we found a lot of pieces over this side, right over the fence, about 600 yards off, but we could not identify them. I ought to say that there was a strong wind blowing in that direction, it was blowing almost due west.

396. And the remains you found were in that direction?—Yes, to leeward.

397. Can you arrive at any conclusion, from the positions in which you found the remains, as to where those four men were when the explosion actually occurred?—I should say Mr. Ingram was standing on the bottom step, but I cannot say anything about the others.

398. Can you tell us which house went first?—No, I cannot.

399. Did you notice any report before the rumbling sound you heard?—No.

400. Was the report very loud?—Yes.

401. Did it do any damage down at the place where you were?—Not that I know of.

(*The witness withdrew.*)

Mr. Edward Pyle, *examined.*

402. *The Chairman.* What is the nature of your employment in the Royal Gunpowder Factory?—I am a plumber engaged on the nitro-glycerine works.

403 Had you anything to do with the nitro-glycerine works shortly before the explosion?—On the morning of the explosion I put a cock on in the nitro-glycerine store; I put that on one of the spare empty tanks.

404. What kind of cock was it?—An earthenware cock, and it was put on by means of three bolts which were screwed up.

405. Was the cock broken or defective?—Those cocks are fitted and cemented into lead faucets, and in time the glycerine eats through the Portland cement, and then we take the cock off and put a fresh one on.

406. Does a leakage develop at that part?—Yes, it leaks through the cement.

407. *Colonel Majendie.* Did you use anything to make it watertight?—Nothing but cement.

408. No red lead?—No, nothing but Portland cement; we have them all ready to screw in and therefore we do not cement them in the house. There are two flanges and we screw them together, with a rubber washer, by means of three gunmetal bolts. [The witness exhibited to the Committee the cock which he took out of the tank on the morning of the explosion, and which has since been repaired.]

409. Do you remove the nitro-glycerine before you commence work?—That is done before we go there.

410. Had this house any glycerine in it when you went there to work?—I did not ask.

411. Was there any in that tank?—No, I asked and they said it had been washed out with hot water.

412. Who said that?—Suckling. Mr. Ingram told me to see him and ask him to send a man down to the house with me; he sent Strange with me, and we put the cock in in about half an hour.

413. When you had completed the job to whom did you report?—To Mr. Ingram, my foreman.

414. After the explosion did you find any of the remains?—Yes, Mr. Ingram's.

415. Near the washing house?—Yes, right facing the door, in a direct line from the door to the hedge, and about 10 yards away from the door. I identified him by his trowsers.

416. That was to the west, facing the door?—Yes.

(*The witness withdrew*)

Mr. George William Dellar, *examined.*

417. *The Chairman.* What is the nature of your employment in the Royal Gunpowder Factory?—I am a danger-house man.

418. Where were you at the time of the accident?—In No. 2 nitrating house; there was a charge in the separator at the time.

419. What did you hear?—I cannot say that I heard anything, and I only recognized the concussion by the house shaking; all the glass was broken.

420. *Colonel Majendie.* Had you got a full charge in the separator?—Yes.

421. How long had it been there?—Probably about 20 minutes.

422. *The Chairman.* How long did it generally remain there?—About 40 minutes.

423. *Colonel Majendie.* Would that have been the next charge to go down to the washing house?—Yes.

424. *The Chairman.* Have you been employed in the washing house?—No.

425. *Colonel Majendie.* Can you say which of the two houses went first?—No, I was inside and I have no idea.

426. In fact, you did not know that two houses had gone?—No, I did not know that it was any place near us at the time.

427. Were you hurt at all?—Just on the side of the head and on the hands by the falling glass.

428. Have you seen anything at any time which would throw any light upon the probable cause of the accident?—No, nothing.

(*The witness withdrew.*)

Mr. William Woodroffe, *examined.*

429. *The Chairman.* What is the nature of your employment in the Royal Gunpowder Factory?—I am a carpenter.

430. Where were you at the time of the explosion?—Between the reeling house and the incorporating house.

431. When had you last seen Mr. Suckling?—At 4 o'clock, at the bottom of the charge house steps, that is between the two nitrating houses.

432. Did he say anything to you?—I had been in No. 1 nitrating house and when I had finished the job, I was to tell him that I was done. I had just finished and I went to look for him; I found him at the bottom of the steps, and I said, "George, I have finished that job, and you can look at it," he said, "all right." I then came down the steps and went down the path.

433. *Colonel Majendie.* Did he follow you?—No, he went towards the washing house.

434. Was Mr. Ingram with him?—No. I went to the top of the nitrating house, and, looking down this road, I saw Mr. Ingram was about level with this hedge, and coming towards the washing house.

435. Then he could not have been at the washing house for any length of time before the explosion?—No, he could only just have got there, because I had gone about the same distance as he had when the explosion happened. Mr. Suckling might have been in there about a couple of minutes.

436. Did you hear two explosions or only one?—I heard only one explosion, and then I was directly knocked down.

437. Do you know at all which house that came from?—No.

438. Had you done any repairs in either of the exploded houses that day?—No.

(*The witness withdrew.*)

Mr. James Henry Player, *examined.*

439. *The Chairman.* What is your employment?—I am a carpenter, employed by the contractor for these works.

440. What were you doing at the time of the explosion?—I was within about 12 yards of the house, and I was engaged in putting up part of the new tunnel.

441. Were you out in the open air?—Yes; we were putting up that fork that you see *there* (*see* Appendix II.).

442. *Colonel Majendie.* Were you pulling down any old tunnel or removing any old gutter, or anything of that sort?—No, there had not been a tunnel there.

443. And therefore there never had been any nitroglycerine at that part?—No; we had been working there for about a fortnight at that time.

444. What did you see and hear of the explosion?—I saw a dull red flash and then some brickwork came flying about; I put my arms and hands to save my head, and then I was knocked down. There was a boy named Mumford near me, and he asked me what it was, and I said "lie down."

445. Were you hurt at all?—Not much, I got my right ear hurt, and he got a bruise.

446. From what you say, I gather you were nearer the store than the other house?—Yes.

447. Can you say which house it was that went first?—No; my back was towards the top place and I was facing the store.

448. Did you see Mr. Suckling or Mr. Ingram?—Not Ingram, but about half an hour before that I was speaking to Suckling, because I wanted to connect my tunnel with the other, and I asked him when I could do it, and he said he would let me know. I think I saw Mr. Bennie coming from the water tower towards the steps.

(*The witness withdrew.*)

Mr. John Gray, *examined.*

449. *The Chairman.* What is your employment?—I am a bricklayer, employed on these works under the contractor.

450. Where were you at the time of the explosion?—I was in No. 1 incorporating house.

451. What did you hear and see?—I heard the explosion, and then the glass came rattling down on me.

452. Did you hear more than one explosion?—I think there were two.

453. Did they follow in quick succession?—Yes. The glass was down on me before I heard the explosion.

454. *Colonel Majendie.* Have you come to any conclusion as to which was the louder of the two explosions?—No.

455. Or which of the two houses went first?—No; in fact, I did not at first know which houses had gone. There was a labourer in the same place as I was in, and he got his foot very badly cut.

456. Was the explosion very loud?—Yes.

(*The witness withdrew.*)

Mr. James Miln Thomson, *recalled.*

457. *The Chairman.* We understand from Pyle, the plumber, that he put a new cock in one of the tanks in the store on Monday morning, the morning of the explosion?—Yes, that was so.

458. Did you know anything of that?—Yes, but I forgot it when I was here just now.

459. Which tank was it?—It would be the one that they ran the new charges into, but which that was I could not say without asking.

460 We understand that the tank had been cleaned out before the man went to work on it?—The man who was weighing washed it out with water first, and then another man was sent down who washed it out with carbonate of soda solution and then wiped it with a clean cloth, and after that the plumber came down and did the work.

461. *Colonel Majendie.* They did not remove the nitro-glycerine from the other tank, did they?—No, because we had no place in which to put it, that is the reason why the other place was being got ready.

462. In making your calculation of 2,200 lb., are you taking what was in the house on Saturday plus the two charges of 750 lb. each?—What was in on Saturday, minus the quantity weighed out that day; it would take in some of Monday's also.

(*The witness withdrew.*)

[Captain Huleatt, R.E., handed in plans of the buildings for the information of the Committee, *see* Appendices II. and III.]

WAR OFFICE.

Friday, 18th May, 1894.

Present.

Lord Sandhurst, *Chairman.*

Members.

Sir F. A. Abel, Bart., K.C.B., F.R.S.
Major-General F. T. Lloyd, C.B.
Colonel V. D. Majendie, C.B.

Mr. R. H. Brade, *Secretary.*

Dr. W. Anderson, *examined.*

463. *The Chairman.* You are Director-General of Ordnance Factories, I believe?—Yes.

464. We understand that you propose to at once proceed with the re-erection, in some form or another, of the buildings which were destroyed at Waltham by the explosion of the 7th May?—Yes.

465. Have your plans been submitted for opinions to anyone at Waltham, besides the Superintendent of Building Works and the Superintendent of the Factory—No.

466. With regard to the form of the buildings, has any suggestion been made?—What we are going to do is to lower the store as much as ever drainage will allow, and also the washing house, to such a degree as will secure a slope of 1 in 26 for the gutters. That slope has been found to be the minimum. Then we shall

lower the nitrating house so as to secure the same fall in the gutters between the nitrating house and the washing house, and we shall, in that way, lower the whole of the buildings about 6 feet. Then the traverses, instead of being rectangular and composed of very thick brick walls, will be circular, the same as the guncotton drying stove, and will be formed with a 3-ft. thick wall all round with earthen slopes outside.

467. What will be the height of the walls?—The washing house wall will appear but very little above the natural level of the ground. Formerly the access to the store was by means of steps, and the mixtures of nitro-glycerine and guncotton had to be carried up those steps; but now we shall make a ramp or inclined passage there, and the slope will be 1 in 12.

468. Has the Superintendent at Waltham had an opportunity of expressing any opinion upon the designs?—Yes. He was present at the conference held to discuss the matter. At that conference we arranged a scheme which was reduced to writing and then submitted to the Financial Secretary. He approved it, and gave me urgent orders to complete the work as soon as possible.

469. *Colonel Majendie.* Has the question of the protection of the buildings been considered with reference to the communication of an explosion, or of explosions, to a building, consequent upon an explosion in another building; that is to say, is it proposed to put the buildings down in pits as formerly?—Yes.

470. Are you satisfied that that is a good arrangement?—It is the best we can think of.

471. Then you do not think there is any possibility that one of these buildings may have been exploded by the air wave being compressed in, and in that way leading to the breaking up of the house?—The communication of the explosion, I think, was done by the ether, by means of which the molecular disturbance was communicated from one building to the other. It is doubtful whether there were two explosions or not; if there were, they followed each other with very great rapidity, faster, possibly, than sound can travel.

472. Are you aware that in some former explosions the same effect has been remarked, namely, that the injury to, or destruction of the houses, was largely consequent upon their being confined in pits from which the air could not escape?—I know that houses which have been in pits in that way have been injured, but I do not think it was because they were in pits, because houses standing quite free were destroyed at the same time. There is a sort of wave formed by a compression, and subsequent rarefaction of the air, and what destroys the buildings, whether in pits or freely exposed, is that they are pressed down first and then raised up afterwards by a sort of bellows action.

473. Is that always the case; here is a house to which our attention has been directed, it was not protected and yet it was blown up?—It just depends upon the way the wave reached it, if it came into the node of the wave it would not be hurt. There was every variety of destruction; some of the buildings that were exposed, such as the gas-engine house just beside the traverse of the mixing house or store, suffered as much as the buildings that had traverses round them

474. Then I understand you do not think that the traverses absolutely surrounding a house are a positive loss to the building?—No, what they do I think is to prevent the lateral effect of an explosion within them, they force the gases up and out in the same way as a gun would.

475. Is it not possible so to traverse a house against those lateral effects, and yet leave an open space for the air?—Yes, to a certain extent, but it should be remembered that two men lost their lives by being in line with an opening in the traverse.

476. I mean in order to get rid of the extreme confinement of the houses, which is rather going to be increased because the houses are to be lower down?—Yes. By our proposal the entrance will be masked by a short traverse.

477. Would not the houses be quite protected as regards lateral effects by having traverses exposed in *that* direction [pointing to the west, as shown on the plan in Appendix I.]?—I cannot say, because of the buildings and workpeople about.

478. Is there not a way to let yourselves out a bit *there* [pointing to the south side of the factory as shown on the plan]?—That is our boundary *there*; I wanted all this land *here* (*i.e.*, to the south of the oak fence, shown on the south side of the factory).

479. From what you say, it seems to me that you are under the necessity of having to adopt a structure which does not entirely recommend itself to everybody?—I cannot agree to that; the less distance we have to take the nitro-glycerine the better. We must have the buildings on a hill, and where in that neighbourhood are we to find hills with sufficient fall? the nitro-glycerine must travel onward only by gravitation.

480. It all comes back to this, does it not, that the site, on the whole, is not a very satisfactory one, either as regards extent or configuration?—Yes.

481. And these reconstructed buildings will be simply an arrangement which you think the best under the circumstances?—Yes, that is so; if I were remaking the plan, I should not do it in the same way, I should make it smaller, and build one half down *here* and another *there*.

482. Do you know whether Colonel McClintock has had an opportunity of expressing an opinion upon these plans?—Yes, he was present at the conference.

483. Did you consider at the conference the question of opening this thing out?—Yes.

484. And is there no solution to the difficulty?—The conclusion was that, in whichever way we left an opening it would not be safe.

485. I do not mean with regard to traverse so much, I mean more with regard to opening out the distribution of the buildings?—I think if that is to be done at all it must be done at quite a different place.

486. Are you in any way satisfied with the present site?—No, I think it is a faulty one.

487. What I am anxious should appear as clearly as possible, is that the arrangements proposed at the conference are simply arrangements adopted in view of the existing condition of things, and the immediate urgency of the occasion; is that so?—Yes.

488. And those arrangements do not exclude the proposition of an improved distribution of the factory, or a reconstruction and development elsewhere?—No.

489. *Sir F. Abel.* Even with the site at your disposal there, you can introduce a distribution which would be more advantageous and which would secure greater safety, can you not?—I cannot say about the "safety"; the serious thing at present is the injury to the buildings and the stoppage of the manufacture, but there ought to be a separate place for some of the working quite away from there.

490. *Colonel Majendie.* Taking the plan of this site as it stands, I see here is a large space of ground, is that absolutely unavailable (pointing to the ground shown on the plan, Appendix I., north of the separating house, in the angle formed by the junction of the Sewardstone Road and Cobbin's Brook)?—That ground was bought on the condition that we should not put anything explosive there. There are some buildings over there (*i.e.*, beyond Cobbin's Brook and Sewardstone Road), and the Secretary of State has undertaken that there should be nothing of a dangerous character put in the field in this corner.

491. *The Chairman.* Then what was the object of acquiring that field?—I do not know, but we are very cramped there.

492. *Colonel Majendie.* But having regard to that condition, are there not some of these houses which you think might, consistently with that condition, be placed *there*?—Yes; our experience is that with cordite there is nothing to fear except a very fierce fire, and, therefore, we might put some of those houses there.

493. And if some of the buildings were moved there, could not you let yourselves out *here* (*i.e.*, on the south side of the factory)?—Yes, certainly.

494. I do not wish to suggest that placing those houses *here* would protect them from injury, but by putting these large houses apart, would there not be a probability that, in case of accident only, one might go off instead of two or more?—Yes.

495. But, having regard only to this site, and without regard to any other, I understand you think this is the best distribution that can be made?—I think it is the only distribution that can be made, but I might be able to make a difference if I were free to go *there* [pointing to the ground referred to in Question 490].

496. Are you not free to go there?—I think not.

497. I am still not quite satisfied that the matter might not be open to consideration as to whether some redistribution of these buildings might not be properly effected, even having regard to the conditions of purchase?—I feel quite certain that anything in the way of cordite would be perfectly safe *there* (*i.e.*, the ground referred to in Question 490), and if that could be done it would relieve us immensely.

498. The question of having a duplicate factory has also occupied your attention, has it not?—I have drawn attention to that several times.

499. And are you still of opinion that it is desirable?—I do not see how we can do without it if we are to be safe from interruption of work due to accident.

500. And you do not think sufficient ground for that could be acquired in this neighbourhood, I understand?—What I think could be done would be to put the cordite factory on the Lower Island, and clear that place of all the gunpowder works, make that place the cordite factory, and keep this for nitro-glycerine.

501. Are the levels the same?—No, but we could keep the nitro-glycerine where it is. There is no doubt but that black powder will come to an end soon, and, even if it does not, we can always buy what we want.

502. Then there are really two ways in which some relief might perhaps be sought, one being a redistribution of the buildings on the existing site, and the other the utilization of some other site for the cordite work?—Yes, my idea has also been to put up duplicate plant here, but not to use it except in cases of necessity; if we did that we should probably move the water tower.

503. With reference to the question of access to the factory, are we to understand that the public have a right of way, but only on Sundays, through the factory, along this path (*see* path marked "right of way" on plan, Appendix I), passing a short distance from the nitrating and washing houses?—Yes.

504. Did that form part of the terms of purchase?—Yes, I think so, though I believe that, under the Act, there is a power to close it, but I cannot say exactly what the power is. I have now ordered that path to be closed.

505. Do many people go along that path?—Yes, I think so.

506. Is there anyone to prevent people going off the path?—No one, except the policeman.

507. *The Chairman.* How far is the path from the washing house?—About 60 yards from the washing house and about 40 yards from the store house.

508. *Major-General Lloyd.* Between what hours is that path open on Sundays?—All day long. We have a footpath *here* (*i.e.*, to the north, east, and south of the factory) which we have ourselves to maintain, and I do not think it would be any hardship to make the public go round by that.

509. *Colonel Majendie.* May we take it that it is in your judgment, objectionable for the public to have the right of way along *this* path?—Yes, because the people are not searched, and they can, therefore, carry matches and all sorts of things about with them.

510. Does that state of things exist in any other factory that you know of?—I should think not. I have closed the path now, and I shall not open it until I am forced to do so by somebody or other; I did that because I was afraid that swarms of people would be coming down to look at the site of the explosion.

511. *Major-General Lloyd.* What amount of police supervision is there on Sundays?—There are the usual patrols about, and when nothing extraordinary happens it is easy enough to keep the people within bounds, but you cannot do that when there is anything to be seen.

512. In ordinary circumstances would there be more than one policeman on that path at a time?—I think not.

513. *Colonel Majendie.* Does this ground to the south belong to you?—That is the field we wanted to acquire.

514. Does this field to the east belong to you?—No.

515. Then what necessitated protecting *this* (*i.e.*, to the north and east) part from possible danger buildings and not *that* (*i.e.*, to the south and east) part?—I cannot say.

516. *The Chairman.* Is there anything else you wish to bring to the notice of the Committee?—I have been trying to find out whether the nitrating work could be regulated and controlled from a distance by means of thermometers inspected by a man with a telescope behind a splinter proof; such a system is carried out in case of dangerous experiments. [The witness explained, by means of the plan, how such a system could be worked with regard to the positions, and explained how a man could regulate the work without being actually in the building.]

517. *Colonel Majendie.* I presume you would resort to that system only if you were sure that a man could have the same control over the operations as if he were in the house?—Yes, certainly.

518. Accidents in nitrating houses have not been common or numerous, have they?—No, but there is a tendency with men to get careless in repeating the same operation over and over again.

(*The witness withdrew.*)

Colonel W. McCLINTOCK, *examined.*

519. *The Chairman.* You are the Superintendent of the Royal Gunpowder Factory at Waltham Abbey, I believe?—Yes

520. We understand that it is proposed to erect some new buildings to replace those destroyed in the explosion of 7th May?—Yes, they have cleared the place and laid the foundations.

521. Have you seen the plans of the proposed buildings?—Yes, I saw them for the first time when the Committee were at Waltham, the day before yesterday.

522. Previous to that were you in ignorance of the sort of buildings they were proposed to be?—Yes. Colonel Sale and Dr. Anderson came down to Waltham the second day after the explosion, and they proposed to re-erect the buildings on the same sites but with earthen traverses in place of the brick ones. I made no objection then, but I have written since and said that I thought the proposed buildings are much too close; that, I think, is proved by the experience of the last explosion, because when one went another went.

523. I understand that at present the two houses are about 65 yards apart?—Yes.

524. What distance would you like to see them apart?—I think the hill is altogether too small for the present scale of manufacture; the only practical alteration that I can suggest would be to use the nitro-glycerine straight away as it is made, and not let it stand at all; that is to say, run each charge down from the washing house and mix it at once, then there would never be more than about 750 lbs. in the building. Of course that would reduce our manufacture very much; but I do not see any other way out of the difficulty if we keep the place on its original plan.

525. *Colonel Majendie.* And that would necessitate the provision of another establishment to supplement the output, would it not?—Yes; there would have to be another Government factory, or we should have to buy from contractors.

526. Have you considered the question of a redistribution of the buildings on the present site?—That was suggested at the conference at which I was present with Dr. Anderson and Colonel Sale; since then I have come to the conclusion that the buildings are much too close and it is not safe to re-erect them and carry on the manufacture as we did before the explosion.

527. And you would propose that if the buildings are re-erected on the old sites, then the quantities should be largely reduced?—Yes, but even so the buildings are too close together.

528. Can the buildings be placed at greater distances apart on the present site?—Yes.

529. Would you now prefer to see the buildings re-erected and going on at a reduced scale, rather than postpone the whole thing?—Yes, I think so; but at present I am not allowed to make any alteration in the system of manufacture.

530. With whom does that rest?—The Ordnance Committee, I understand; when I came to the factory my orders were to make no alterations at all in the manufacture.

531. Can you put before the Committee exactly what alterations you would wish to introduce?—At present the only alteration I can think of is mixing the charges as quickly as they are washed.

532. How would that entail an alteration in manufacture?—We could not make so much nitro-glycerine then, because up to the present the custom has been to let the stuff settle for a day before using.

533. Is that one of the conditions of manufacture from which you cannot depart?—That is one of the conditions I found when I went there.

534. Was there any specific statement of manufacture laid down for your direction and guidance?—No

535. Do you know whether those who laid down the conditions of manufacture regarded that as material?—I only know what Mr. Thomson told me, and he said that it was considered advisable that the nitro-glycerine should stand so that the 1 per cent. of water might be separated from it.

536. At any rate you consider that is a detail which you would not be at liberty to vary without authority?—I do.

537. And you think if you reduced the amount to the quantity you suggest, the present distances between the houses would afford you a reasonable security?—Yes.

538. Has the question of the re-arrangement of these buildings ever come under your notice, or have you yourself ever proposed any redistribution of them?—No, I do not see how it is possible to do that, having regard to the existing site.

539. If you had more room would you desire to see the buildings separated more?—I would certainly not have the cordite factory so close to the nitro-glycerine store. It is a matter of great surprise to me that more men were not killed the other day, and only that the glass was shattered to very small pieces, more would have been killed. The skylights in the cordite factory were shattered into little bits of not more than 2 oz. each.

540. Had you anybody seriously wounded?—The chief engineer was hit in the breast by a brick, and he had hemorrhage of the lungs for two days; he was standing behind the incorporating house when the explosion occurred.

541. From what you say, I gather you do not hold yourself responsible for the existing state of things?—No, not in any way.

542. But you do desire to make such a modification in the manufacture as will enable you to dispense with any accumulated store of nitro-glycerine?—Yes.

543. And you think if that is not done, the distances are too short?—Yes.

544. With reference to the right of way over the footpath near these houses, do you consider that objectionable?—Yes. At present a large number of men, women, and children go across that part on Sundays and bank holidays, and that right of way affords an opportunity for evilly-disposed persons to come and study the places if they want to.

545. Does it give them an opportunity to wander about at all?—No, not in the daytime, if the police do their duty.

546. Have you had any cases of people wandering about brought to your notice?—On one occasion, on a Sunday, I was walking about there, and I heard a policeman shout to some people to keep to the path.

547. What can you do with people who go off the path, can you summons them for trespassing?—Yes, I think so, but I cannot say for certain, as the question has never been raised.

548. Were there many people about on the Sunday preceding the explosion?—I have not heard that there were more than usual.

549. Have you heard of anyone being seen wandering about improperly?—I have had no reports of that.

550. With reference to the construction of the house that was blown up, had it a skylight?—No, it was lighted from the side.

551. Therefore the sun would not shine into the house?—I think not, looking to those traverses; they were too high.

552. Was the day of the explosion a sunny day?—Yes.

553. Were the tanks covered in any way?—Yes, they were covered.

554. And, therefore, if the sun did shine into the place, it would not shine on the nitro-glycerine?—No.

555. *Sir F. Abel.* You say you received instructions when you went there not to depart in any way from the existing system of manufacture?—That is so.

556. Had you any detailed instructions given you regarding the existing system of manufacture?—No. The manufacture was in operation when I went there, and I carried it on.

557. The work being entirely under the manager, Mr. Thomson?—Yes.

558. And anything which he stated as necessary you considered was part of the recognized system of manufacture?—Yes.

559. *Colonel Majendie.* Had you any chemical knowledge and advice at your disposal, apart from that given you by Mr. Thomson?—If I had asked for it, I could have obtained it.

560. Has Dr. Kellner ever rendered you any assistance, or have you ever had occasion to ask for his assistance?—When cordite has given unusual results, they have tried to find out the cause, and he has frequently analysed cordite for us in his laboratory at Woolwich.

561. *Sir F. Abel.* But he has never been consulted in regard to the details of manufacture, such, for example, as the rule of allowing nitro-glycerine to stand?—Not to my knowledge.

562. *Colonel Majendie.* Has Dr. Dupré been in any way called in as a consulting adviser?—No, I cannot say that he has.

563. Apart from those two gentlemen, what chemical assistance have you?—Four practical chemists, Mr. James Miln Thomson, who had charge of the whole of the manufacture; Mr. William Thomson, his younger brother, in charge of the guncotton; Mr. Bennie, who was killed was in charge of the nitro

glycerine; and Mr. Robertson, in charge of the laboratory.

564. The two Thomsons had had practical experience in the manufacture of nitro-glycerine before they came to you, had they not?—Yes.

565. Had Mr. Bennie been at Ardeer?—I think not.

566. Has Mr. Robertson?—I think not.

567. Going back to the question of the plans, have you studied the plans which you say you saw the other day for the first time?—No.

568. Then you desire to take no responsibility in regard to them?—That is so.

569. With regard to the guncotton stove, No. I., which was practically destroyed by the explosion, although surrounded by traverses, we understand that that contained cordite at the time?—Yes.

570. How much?—3,000 lbs.

571. What was it doing there?—Being dried by hot air.

572. Was the cordite laid out on trays with the hot air going over it?—Yes.

573. Did that cordite sustain any injury?—No, none whatever.

574. *Sir F. Abel.* You mean, by being dried, that the volatile solvent was being driven off it; but that is itself inflammable?—Yes.

575. *Major-General Lloyd.* Have you ever raised any objections to the relative situations of the houses at the nitro-glycerine and cordite factories?—I have expressed the opinion that they were too close, but I have not put that in writing; I have done it only in conversation.

576. With whom?—The Director-General of Ordnance Factories.

577. Of course, the whole of the process of manufacturing nitro-glycerine is dangerous, but is there any detail which you think is specally dangerous?—Yes, the nitrating is a very dangerous process indeed, but we do not consider the washing very dangerous.

578. Is there any detail in the manufacture which you have ever expressed a wish to have altered in any way with a view to safety?—No.

579. What is the actual amount of police supervision over that right of way on Sundays?—The gates are open during the hours of daylight, and during that time two men are always there.

580. Are there any means of preventing people from trespassing on that part during the night time?—There is a police patrol.

581. Is he on that path or in the neighbourhood of that path all night?—No, he patrols all round.

582. Including the powder factories?—No, only the cordite and guncotton factories; there is another man for the Lower Island, where the cam houses were.

583. Had you every reason to be satisfied with the way in which the work of watching was carried out by the police?—Yes, I have never had any reason to suppose that they neglected their duties.

584. But do you consider that that amount of police supervision was amply sufficient to prevent any unauthorized intrusion?—No, because the place is so open that anybody could get in and damage the place if he liked; but the number of police required to ensure perfect safety would be very considerable. Any active man could easily get in on the north side, and on the east side there is only a wooden paling.

585. *The Chairman.* Are there any lights about at night?—Yes, there are lights in the cordite factory and about the roads.

586. At night anybody could walk about the property without being seen by the police?—Of course, the police have a large area to patrol.

587. *Major-General Lloyd.* At the conference at which you were present with Dr. Anderson and Colonel Sale, certain modifications were provided for with reference to the way in which the new buildings were to be erected?—Yes, among other things the buildings were to have circular traverses instead of square ones, the roofs were to be covered with zinc instead of tarred felt, and they proposed to lower the store and the washing house as much as possible so long as the same gradients were kept for the purpose of allowing the nitro-glycerine to flow down the gutters.

588. *Sir F. Abel.* The gradient, we understand, is to be increased if possible?—Yes, but not to be less than 1 in 26.

589. *Major-General Lloyd.* The guncotton store was to be converted to some other use?—Yes, into a duplicate nitro-glycerine store.

590. Did you agreee to those alterations so far as they went?—Yes

591. So far as they went you entirely approved of them?—Yes, but I have since expressed my opinion that the buildings should not be rebuilt on the old sites.

592. And you think if those buildings are erected as proposed, greater safety will be secured than previously existed?—So far as the form of the traverses is altered there will be less chance of bricks being sent about, but after our experience of the last explosion, I do not see how the traverses will protect one house from an explosion in another. If we keep these large quantities, I think if the store were detonated tomorrow it would affect the washing house, as it did the other day, no matter what the traverses were.

593. Suppose you had unlimited space for the erection of structures of the kind required, at what distance apart would you think it necessary to put the danger buildings?—I think 200 yards might do if you had very heavy traverses between.

594. *Colonel Majendie.* You say if the nitro-glycerine store detonated as it did the other day it would again explode the washing house; that implies, does it not, that you satisfied yourself that the nitro-glycerine store detonated first?—Yes, from the evidence I have had.

595. But is there any other evidence which you have got which confirms that evidence?—Merely a theory of mine, that the greater amount detonated is likely to detonate the lesser amount.

596. Do you mean by that that you think a ton would be more likely to detonate 1,500 lb. than 1,500 lb. to detonate a ton?—Yes.

597. You heard the explosion, did you not?—Yes.

598. Were there two?—I could not say there were two distinct explosions; it began with a roar and ended with an explosion.

599. The loudest noise was at the end, was it not?—Yes, as I heard it.

600. The greatest quantity of the material was in the store, I understand?—Yes. The idea you get of an explosion depends very much upon the locality you are in, and also on how the wave of sound reaches you.

601. As far as the evidence goes there was apparently no work carried on in the store except the weighing of nitro-glycerine and its absorption in guncotton?—That was all that was done; there was no machinery there, only the tanks, and the gun-cotton was brought in in brass-lined boxes.

602. But that work even was not going on at the time of the explosion?—No, I cannot tell you exactly when it stopped; but the man locked the place up five minutes before the explosion. I had been in there with a party of visitors between 12 and 1.

603. Is anybody missing in connection with that house?—No.

604.—The house, so far as the evidence goes, was locked up and idle?—Yes.

605. Are you quite sure that the nitro-glycerine then in that house was purified nitro-glycerine?—Certainly, I have no doubt about it.

606. *Sir F. Abel.* It was not tested nitro-glycerine?—Every batch is tested.

607. It was not tested at the time, I believe?—Then it would be afterwards; the test is always going on.

608. There were two batches, the tests of which were not complete?—That is so, but the test for acidity was made.

609. *Colonel Majendie.* Have you been able to form any theory as to how it was that the house went first?—I can only suppose that it was foul play; the stuff in that house could not have gone off by itself.

610. Do you consider that it was a safer house than the washing house?—Yes, much safer.

611. With regard to the suggestion of foul play, do you think that there were opportunities by which evilly-disposed persons might have had access to that place?—Yes, I think it was possible.

612. *Sir F. Abel.* There were men employed in that house in the morning, but was there any part of the place where any exploding arrangement could have been placed without being seen by the men while going about their ordinary duties?—An infernal machine might have been placed outside the building in the traverse; I do not suppose that any of the men went right round the building every day.

613. *Colonel Majendie.* I presume a stranger wandering about in the daytime would be observed, would he not?—There are building works men and contractors' men about; I often meet gangs of men I do not know; in fact, I cannot always tell whether the men I meet are my men or not.

614. *The Chairman.* Do not all the men wear a particular red uniform?—My men do, but the building works men do not.

615. *Major-General Lloyd.* Has it ever occurred to you to provide the workmen with arm-badges or numbers?—I think in a factory of this sort such a thing would be a good protection.

616. *Colonel Majendie.* You are not satisfied with the present arrangement by which comparatively unknown men are able to wander about?—No, I am not.

617. *The Chairman.* Can you tell us the total amount of nitro-glycerine turned out at the factory since the manufacture was started, and the rate per annum of the manufacture?—The nitro-glycerine manufacture was as follows:—

	lbs.
March 16th to March 30th, 1891..	617
April 1st, 1891, to March 31st, 1892	99,900
„ 1892, „ 1893	297,675
„ 1893, „ 1894	417,600
„ 1894, to May 7th, 1894..	64,080
Total ..	879,872

Those figures give an average rate per annum of 271,725 lbs.

618. Can you state the number and character of the accidents you have had since the manufacture was started?—We have not had any accidents.

619. What is the number and character of the changes you have made in the processes of manufacture, and in the character of the ingredients?—(1) increased quantity of glycerine nitrated at one time from 330 lbs. to 350 lbs., and acids proportionately, October 1892; (2) altered time of washing, namely, March 1891 to August 1892, three washings extending over three hours, including removal of washing water, November 1893 to May 7th 1894, four washings extending over 1½ hours, excluding removal of washing water.

620. What are the alterations that have been made in the machinery?—(*a*) December 1892, added water jacket to nitrating apparatus in No. 1 nitrating house; (*b*) October 1892, added surface cock in separators to run off nitro-glycerine before acids; (*c*) June 1892, added leaden shields to washing tanks in washing house, to prevent splashing of nitro-glycerine on floor; (*d*) November 1893, altered cocks in washing tanks, filter and store tanks, by adding brass flanges with leaden washers in place of cemented cock, direct in faucet of tanks; (*e*) May 1893, substituted beakers and bottles made of gutta-percha, in place of glass, for sampling nitro-glycerine in washing house.

621. Have any alterations been made in the construction and position of the buildings?—No.

622. Can you state the measurements of the distances between the several buildings at Quinton Hill works?—

	Feet.*
No. 1 nitrating house to No. 2 nitrating house	61
Nitrating house to washing house ..	95
Washing house to nitro-glycerine store	235
„ to No. 1 guncotton stove	328
Nitro-glycerine store to wash water settling house	218
Wash water settling house to washing shed	84
Nitrating house to after nitrating house	49
„ to water tower ..	193
Washing house to dry guncotton store..	445
Nitro-glycerine store to dry guncotton store	350
Nitro-glycerine store to guncotton weighing room	180
Nitro-glycerine store to reeling house ..	260
„ „ to reel store ..	622

623. Are there any papers which you wish to hand in for the information of the Committee?—Yes, here is a statement showing the damages to buildings caused by the explosion of May 7th, and a statement showing the radii within which serious structural and other damage was effected by the same explosion [handing in the same, Appendix VI.].

624. Is there anything further which you wish to say?—Yes, I think my position is now an almost intolerable one. I am held responsible for the working of the factory; but, the building works being independent of me, renders it very difficult for me to know whether only the proper people are moving about the factory. The estate, which was in the hands of my predecessor, is now under the building works, and that leads to people being brought into the factory who are not under me. We have, at times, found the marks of men's boots on the "clean" platforms, no one would confess to having made those marks, but I do not thin my own men would trespass in that way for their own sakes. With reference to the buildings themselves, I frequently ask for various alterations to be made, and to some of those requests the answer is made that the Superintendent of Building Works does not agree with me; his opinion is taken in preference to mine, yet I am the responsible person and he is not. Here are a few examples: No. 4 granulating house. My predecessor refused to use that house because it had only partial match lining, and I have always refused to use it. Then there is the pathway from the shifting house, part of it has a tar paving, but there is about 100 yards which has no paving at all, and the consequence is that, in wet weather, after putting on their lasting clothes in the shifting house, the men have to walk about 100 yards on muddy ground. Then, again, the traverses between the shoe-rooms and the danger buildings are of brick and mortar, and the mortar is perpetually tumbling out on to the "clean" platforms, I have asked to have them cemented all over, parts of them have been pointed with cement, but, as I have pointed out, that does not last, and I consider that a source of danger. I have asked to have match-lined various porches of the small magazines; in some cases it has been done, and in other cases not. Since the last explosion, I have asked that the men should get underclothing from the Government in order to prevent the wearing of private clothing, but I was informed by the Director-General of Ordnance Factories that the cost would be too great. Since then I have repeated my request, and I was informed that nothing could be done until Lord Sandhurst's Committee had reported. I now repeat that request again. I contend that, as I am responsible, I ought to have more authority, and I think every man in the factory should be under me. I also think that the buildings should be altered as I require them; but, if my opinion is considered valueless, then the matter should be referred to Her Majesty's Inspector at the Home Office. Here are the conditions

* These measurements are the distances between the *centres* of the several buildings.

with regard to the duties of Superintendent, which were handed to me when I took up the appointment [handing in the same, Appendix VII.]. Paragraph 2 certainly states that all persons employed in the factory are immediately responsible to the Superintendent, but you will see that that is entirely nullified by the later paragraphs. I can, if you require them, supply you with copies of the correspondence which has taken place with reference to the points I have just mentioned. Here is some correspondence [handing in the same, Appendix VIII.] with reference to a drunken bargeman who tried to get into the factory; when I called attention to the matter, I was told that "such misconduct will recur." Here is some more correspondence [handing in the same, Appendix VIII.] referring to a contractor's drunken labourer, who tried to get into the works; I forwarded the report to the Assistant Superintendent of Building Works, and the man was "admonished"; if it had been one of my own men, he would have been discharged.

625. *Colonel Majendie.* Are the arrangements at Quinton Hill for searching the men, and changing the clothes, practically similar to those which are adopted in the Gunpowder Factory?—Yes, but since the accident last December the precautions have been considerably increased. We now have the clothes occasionally searched in the shifting rooms, and we also have the men searched by the foremen, who have to report in writing that they have done so. The police have orders to search more men, and they do so. Those changes have been made since the accident in December last, but up to that time the arrangements in both factories were much the same.

626. *Sir F. Abel.* Are you satisfied with the system which has been in operation in the nitro-glycerine works, by which, when repairs were from time to time carried out, the completed apparatus or works were inspected by the foremen and other responsible men before the work was resumed?—I have every reason to believe that the plant was carefully examined before its use was resumed.

627. Had you a guarantee, in the form of a written statement or signed certificate, that that had been done?—The foreman plumber sent in a weekly report showing that every bit of the apparatus and plant had been examined every week.

628. It is essential when repairs are carried out that it should be certified that everything is in a thoroughly efficient condition before men go to work again; had you any guarantee that such an inspection was always carried out?—Only that the foreman was a very trustworthy man.

629. *Colonel Majendie.* Did he actually always report to you?—Not in the case of every single repair.

630. *Sir F. Abel.* The weekly report, I understand, related to the condition of the whole plant, but it did not relate to any portion under repair?—That is so.

(*The witness withdrew.*)

Colonel M. T. Sale, C.M.G., and Captain H. Huleatt, R.E., *examined.*

631. *The Chairman* (to Colonel Sale). You are the Superintendent of Building Works, and Waltham Abbey is under your charge, I believe?—Yes.

632. Is the present arrangement of the buildings the best for such a manufacture as is there carried out, or is it the best arrangement that you can make, having regard to the area of ground at your disposal?—I think if we were starting afresh, and knew what we know now, we should probably recommend some different arrangement, but not very widely different. The fall of the ground, to a very great extent, ties us in our arrangements.

633. Supposing it were possible, would you like a larger area?—Yes, I should prefer to have the buildings at a greater distance apart.

634. *Colonel Majendie.* Have you the plans of the new buildings here?—Yes, here they are [handing them in for inspection by the Committee, *see* Appendix XII].

635. Are these proposed buildings on the site, or sites, of the exploded buildings, or are they on new sites?—On the exact sites of the old ones.

636. Why have you taken the exact sites?—Because we are practically tied down to that ground.

637. They are not sites of your own selection, are they?—When the conditions were given that site was decided upon.

638. Have you been moving in fetters from the beginning, both as to area and fall?—Yes.

639. Do those fetters still hold you?—Yes, undoubtedly.

640. In the reconstruction of these buildings, what alterations have you seen your way to make in the direction of increased safety?—The main idea is to greatly increase the strength of the traverses, and also to put the store much lower down in the ground, giving much higher traverses and making them of earth instead of brickwork. When the traverses are made of earth we can get a much greater mass, and the parts do not fly about so much if there happens to be an explosion; in this accident the bricks flew about especially towards the east, but much less than was expected. The bricks from the washing house flew about very little or not at all.

641. You are sinking these houses lower down, both for the purposes of limiting the area of a possible explosive effect and also to get a better fall?—We get a better fall, but it is rather to shield the buildings from explosions elsewhere.

642. Before proposing the re-erection of these buildings, had you considered the possibility of placing them a little further off?—We went very carefully into that, but I am afraid it is not possible.

643. On account of the area or on account of the fall?—It is mainly a question of fall.

644. Then, practically, the site for these purposes is not a very convenient one?—It is not an ideal site, but it would be very difficult to know where to get a better one.

645. But if you were free to move about in the United Kingdom you could get a better site?—We could get a less inhabited site.

646. Do you think, having regard to the impossibility of moving these houses to greater distances, that this site is suitable for the amount of production required?—Yes, if the necessity of storing a large quantity of nitro-glycerine can be got over.

647. You think they may nitrate what they do there, and wash what they do there?—Yes, I look upon it that the damage arising from those places would have been comparatively slight, even if they had both gone off.

648. Do you make provision in these new buildings for the same store as before?—Yes, as far as the housse themselves are concerned.

649. We have been told that the guncotton stove, No. 1, is to be adapted as a supplementary store?—It was intended to do that, but the intention is at present in abeyance; since the conference there has been raised the question of either having a store somewhere apart or of not storing so much, and therefore that house is left for the present.

650. With regard to the traverses, are you making arrangements by which there will be a greater length in the traverses?—The drawings show that, owing to the traverses being of earth, and being of comparatively great slope, they will not be so much in a well as before.

651. They will not be so confined as before, will they?—No.

652. Is it possible, without detriment to the buildings, to relieve the traverses at all in other ways?—At present it is arranged to make them circular in plan, but it is possible to make them in the shape of a U, though that would be more expensive.

653. In what direction would you make the mouth of the U?—Probably towards the west, where there is a greater distance free of buildings, but it would be essentially necessary to have an auxiliary traverse enclosing the U and at a little distance from it.

654. Is there any difficulty in making U-shaped traverses, beyond that of the extra expense involved?—Extra expense and time.

655. How would you turn the U *here*?—I should eliminate that building.

656. Is that to be reconstructed?—No.

657. Will the buildings be reconstructed of the same materials as formerly?—Yes, they will be of the same material, except that in place of the tarred felt roofs we shall put zinc, though the tarred felt behaved remarkably well, and that in the neighbourhood of the explosion suffered very little. The Superintendent has asked that instead of there being a boarded floor leaded over, it should be a solid floor with lead over it.

658. *The Chairman.* Why is it thought desirable to change the roofs?—The Superintendent of the factory is very anxious that it should be done on account of the tarred felt being liable to fire. It is a remote contingency, and our experiments do not bear out that view of the matter.

659. *Colonel Majendie.* How will the windows be placed?—They will be put under the eaves of the building; there are no overhead lights.

660. Were there any skylights in the old buildings?—No.

661. Can the sun reach the interior of the building?—I cannot say off-hand.

662. Will the windows be of ordinary glass?—Yes, as they were formerly.

663. Have these plans been seen by Colonel McClintock?—The actual plans have not been seen by him, but they are in accordance with the points agreed upon at the conference.

664. Are there any details which it would be desirable that he should have an opportunity of examining before they are put up?—Every detail has been pointed out to him, and Captain Huleatt is in close communication with him upon all the points. The houses will be match-lined and varnished, and with leaded floors.

665. *The Chairman.* Are they "clean" floors?—They are practically "clean" floors, except that the special precautions for dusty buildings are not introduced.

666. *Colonel Majendie.* With regard to the suggestion of a differently shaped traverse, would the U traverse be contrary to what was agreed upon at the conference?—I think at the conference only the circular traverse was mentioned. In the ordinary way when plans are prepared they are sent to the Superintendent of the factory; but in this case of extreme urgency we had to begin the work really before the plans were prepared.

667. By what time would it be necessary for you to know what form of traverse should be built?—I think if we knew in a week's time we should be all right for the store; but by to-night we shall be as high as we can go with the washing house. If there is to be a change in form we should like to know at the earliest possible moment.

668. Are the men employed under you marked or distinguished in any way?—At present we are largely using the men of the factory who have been thrown out of employment by the explosion.

669. But there are men who do not belong to the factory?—Yes.

670. Whose men are they?—Many of them are men hired from the contractor month by month; they are the men who really do most of our work.

671. Are they known necessarily by sight to any of the officials connected with the factory?—Yes, a stranger in the factory would be noticed by the police; all the day workmen are known to the police.

672. *The Chairman.* Are those men kept on for a long time in the employment of the factory?—Yes, they are kept on from week to week and from year to year.

673. There is no badge to distinguish them by, is there?—No, there is not enough of them, such a thing is not worth our while.

674. *Sir F. Abel.* Are they amenable to the discipline of the factory?—Yes, in each contract there is a distinct clause to the effect that the men are to work entirely under the rules of factory, and upon any breach being committed, the contractor will be called upon to remove or dismiss the men.

675. Would that be done by the Superintendent?—The complaint would come to Captain Huleatt, who would then see the Superintendent upon the matter; no difference of opinion has arisen upon that point for years.

676. *Colonel Majendie* (to Captain Huleatt). Do you know whether any new men have been taken on recently, or have all your men been employed for some time?—There may be two or three fresh ones. The hospital has been started by an entirely new lot of men, but they would not go to the factory. There are also some new men making a drain at the guncotton factory.

677. Would they be able to go about the cordite works?—There is no physical obstacle to prevent the men from the guncotton factory from doing so, but the men from the hospital could not.

678. They would not be known personally to the Superintendent and his people?—No, but of course they have to pass the police at the gate.

679. If the Superintendent saw a man in the cordite factory whose work was in the guncotton factory, he would not know whether he had any business there or not?—No.

(*The witness withdrew.*)

[Note.—Colonel Sale subsequently sent to the Secretary a memorandum on the subject of the plan of traverse to be adopted in the reconstruction, *see* Appendix IX.]

Dr. A. Dupré, F.R.S., *examined.*

680. *The Chairman.* You are the chemical adviser to the Explosives Department of the Home Office, and an Associate Member of the Ordnance Council, I believe?—Yes.

681. You have had considerable practical experience in connection with explosives, have you not?—Yes.

682. Have you visited the scene of the late explosion at Waltham?—Yes.

683. Have you arrived at any conclusions, or formed any opinions, with reference to the state of things you found there?—Yes, and I think the following points must be considered in regard to the matter. First of all,

with regard to the explosions themselves, I do not think the two explosions occurred simultaneously, one was caused by, and came after the other, but the question is, which was first. Putting aside the question of foul play which Colonel McClintock seems to think probable, I think it is scarcely conceivable that the store house should go off of itself. Such a thing would be quite contrary to all our experience, though of course there might have been an accident inside the house itself. Then, secondly, we come to the washing house, connected with which were several dangerous points, and the first to be noticed is the high temperature of the washing water, which went up to, and might even be higher than 50 degrees centigrade. At such a temperature as that nitro-glycerine is very sensitive to shock or concussion.

684. *Colonel Majendie.* Have you proved that by experiment?—Not with nitro-glycerine, but I have with dynamite. I have, however, proved with nitro-glycerine, that at higher temperatures the explosion is far more likely to spread. At ordinary temperature, as a rule, only the part struck explodes, at higher temperatures the explosion spreads, and the whole mass goes off. Then, thirdly, at the bottom of the tub in which the washing was carried on was a tap, which was turned off every time that a washing was completed. In that same tub was also a leaden pipe coiled round and resting on the bottom, and only fixed at the top. Attached to the tap was a flexible tube, at the top of which was a heavy leaden vessel called a "skimmer," and that was let down gradually into the tub, by means of a cord attached to a pulley, every time a lot of material was washed, and the water (and some nitro-glycerine) ran down the skimmer, through the flexible tube and then through the tap. The great danger in that arrangement was that the skimmer might come down with a run on to the nitro-glycerine. Next, every time they let the water run out they turned the tap. Now, if you warm a tap outside, you ease it, but if you warm it inside you make it stick, and during the time of the washing, the material inside the tub may have expanded the tap on the inside, and then it would require force to turn it and where force is used for such a purpose there is always a serious danger. Then, fourthly, with regard to the lead pipe on the bottom, that had actually no fixture, and when the air was sent through it it was sure to vibrate and rub against the bottom of the tub, it might even knock against the side. Now, I find that a 1-lb. weight falling from a height of 45 inches will explode nitro-glycerine at a temperature of 50 degrees centigrade placed between two discs of lead, and it is, therefore, probable, with reference to the skimmer, that the dropping of 30 lb. of lead through nitro-glycerine at a temperature of 50 degrees centigrade upon the bottom of the tub might send it off, and the same thing might happen if the skimmer came down with a run and struck a blow against the side of the tank. Then, again, there was no proper arrangement to prevent the wash-water being hotter than 50 degrees; they trusted entirely to the judgment of the man who let in the hot and cold water. Of course those are only possibilities. The fifth danger, I think, was this. I am told that they were in the habit of taking the nitro-glycerine from the washing water tank and conveying it in buckets into the other house for the purposes of use and if they did not want it at once, it was put on one side and left there. That nitro-glycerine had been washed, but there was no care taken to see that no grit or dust got into it.

685. What you apprehend would be mechanical impurity, and not chemical impurity?—That is so. I think we may leave out of consideration the idea of explosion having been due to spontaneous ignition of the nitro-glycerine. The different batches were in various states of washing, and the explosion occurred at a time when the tap had to be turned. The plumbers were in the house on Saturday, and it is startling to find that the accident happened so soon after they had been there; in fact, one comes to the conclusion that there was some connection between the two things. Perhaps the pipes were not properly fixed, they may have been movable when they were left. Here is a list of the articles found in the washing house just before the explosion—

Buckets, wood, with copper bands	5
,, indiarubber	1
Brushes, hand	1
Brooms, bass	1
Boxes, wood	2
Beakers, guttapercha	1
,, glass	1
Bottles, guttapercha, for samples	18
,, glass	2
Goloshes, leather, pairs	2
Keys, phosphor, bronze	1
Mops	1
Mats	1
Mauls, wood	1
,, lead	1
Rings, copper, for filter	2
Stirrers, wood	1
Scrppets ,,	1
Skimmers, earthenware	1
Slates, framed	2
Stools, wood	1
Sticks ,,	1
Thermometers, glass	2
,, wood	1
Weights, lead	2

I cannot say whether all those things should have been there.

686. Do you think they increase the possibilities of accidents?—Yes; for example, take the earthenware skimmer and the glass vessels, they might all be sources of accident. But I must repeat, in regard to that, that I think the most serious sources of danger were the high temperature, the fact of having to turn on the taps at that high temperature, and the existence of the air pipe, fixed only at the top, and the heavy skimmer.

687. With regard to the high temperature, you do not suggest, do you, that it was so high as to render probable chemical action?—No, only that it produced a highly sensitive state in the nitro-glycerine.

688. Do you think the material can be washed at a lower temperature?—Yes, the great point is to get as much air as possible. With regard to the tap, I asked whether it was turned every time, and I was told "yes"; but I do not see why that need be, because only when you use the skimmer does anything go down the pipe, and, therefore, there is no necessity for turning the tap every time.

689. And you are decidedly of opinion that there is a risk in turning the tap?—Yes, at that temperature.

690. I understand you have taken samples of the nitric acid and the glycerine?—Yes, the glycerine and sulphuric acid are good, but the nitric acid is not as good as it might be. [*See* Appendix X.].

691. *Sir F. Abel.* We find that there was great difficulty in the separation of the glycerine, can you ascribe that to any cause?—We cannot find that out, chemically; we can only find out that something is wrong when it comes to the manufacture. If you test the glycerine, you can find out whether it is pure or not, but you cannot find out why it will not separate.

692. *Colonel Majendie.* Is there anything in that which, in your own mind, you look upon as suspicious in regard to this explosion?—No.

693. Have you had an opportunity of examining or testing the nitro-glycerine produced?—No, I have not done that. I told Colonel McClintock it would not be wise to use the nitro-glycerine found in the nitrating house, because it had not been properly washed, and it ought not to be made into cordite, which I understand they propose doing.

694. Has it been washed?—Yes, but not properly, I think.

695. *The Chairman.* Why should it not be made into cordite?—The great danger in nitro-glycerine is not in the acid, but in some compound which comes out, chiefly in the aëration, and, therefore, nitro-glycerine, which is not sufficiently aërated, will not stand

long storage; if it is stored, in a year or two it may become dangerous.

696. *Colonel Majendie.* What do you think ought to be done with it?—As its stability is not sure, I think it ought to be destroyed.

697. *The Chairman.* Have you recommended that to Colonel McClintock?—Yes, and Dr. Kellner agrees with me.

698. What was the quantity of nitro-glycerine rescued?—About 750 lbs., I think, and, as there is just now a great talk about cordite, I think it would be a great pity to run any risk by using bad stuff.

699. Are you aware that there is some evidence of a very precise character that the explosion originated in the other house?—I cannot believe that it did, and if it were so, it would be better to leave off the manufacture of nitro-glycerine altogether.

700. Have you any experience of the quality of nitro-glycerine originally produced at Waltham?—No, I have never had any samples.

701. *Sir F. Abel.* But you have had plenty of experience as regards the heat test of cordite made from it?—Yes, I have made plenty of tests with reference to cordite.

702. *Colonel Majendie.* And would it be contrary to your belief, and, so far as it goes, your experience, that the material should be impure in the store?—Yes, I fully believe it was pure nitro-glycerine in the store.

703. And do you also believe that what was in the washing house had arrived at a stage in which it might have been called pure nitro-glycerine?—Yes, if you kept it for only a few hours, but not, perhaps, if you were going to keep it for some months. I have had nitro-glycerine, quite acid, which stood for months; it depends entirely upon the conditions of temperature.

704. Do you consider a washing house a dangerous house?—No, I have never heard of accidents in a washing house before.

705. *Sir F. Abel.* Would you consider it a source of danger if nitro-glycerine were spilled upon the floor and if men walked on it with muddy and gritty boots?—Not in an ordinary house, but where there were tubs of nitro-glycerine standing about, that might be a source of danger. I think nitro-glycerine ought never to have been returned to this washing house, it ought to have been washed in a separate house.

706. *Colonel Majendie.* Then do you think that having got a washing shed separate from the washing house, they ought to have carried on the washing of the refuse nitro-glycerine in that washing shed, rather than in the washing house?—Yes, certainly.

707. Have you formed any conclusion in your own mind as to how, or why, one explosion followed the other?—I think it must have been by a great wave of compression through the air crushing in the store, it would travel there in about one-sixth part of a second. I think that view is corroborated by what happened to the nitrating and guncotton houses.

708. One-sixth of a second, that of course would be much quicker than any débris could arrive in one house from the other?—Yes, and so quick that nobody would notice an interval.

709. With reference to the case of an explosion of fulminate which occurred in a factory last Christmas, do you remember that a second explosion happened?—Yes.

710. Was that second explosion produced by the débris of the house in which it happened?—Yes.

711. The first explosion broke up the house and the débris of the house so broken up, exploded what remained of the fulminate?—Yes.

712. And do you conclude that this store house was broken up, and the stuff inside exploded by the débris of that house?—Yes.

713. And, therefore, do you think it would be an advantage that the protection afforded by traverses to houses of this sort should also allow a considerable vent of air, in order to prevent the localization of their compression?—Yes, if it can be done.

714. If it is desired to reduce the quantity of nitro-glycerine kept, do you see any objection to the suggestion of passing the nitro-glycerine from the washing house into the store, and then and there absorbing it in the cotton?—All nitro-glycerine made in one day ought to be mixed with guncotton the same day; when once it is absorbed the danger is very greatly reduced.

715. You do not think there is any necessity to mature nitro-glycerine, so to speak?—No.

716. *Sir F. Abel.* Then I understand you do not consider any importance can be attached to getting rid, by subsidence, of the half per cent. of water, retained in the nitro-glycerine, before its application to cordite?—I do not think that is important, you see the nitro-glycerine is filtered. I think that amount of water would be quite neutralized by the amount of acetone used in the manufacture of cordite.

717. *Colonel Majendie.* If the site admitted of it, do you think it would be an advantage if the houses were moved out?—Yes, I think the cordite might be put anywhere, there is no danger of an explosion with that, only a danger of ignition, and no doubt it would be an advantage to have the nitro-glycerine houses spread out, if the cordite houses could be moved.

718. Do you consider that this accident in any way impairs the reputation of cordite?—No, I do not think it has any bearing upon cordite. I am strongly of opinion that when you deal with explosives you must make up your minds for occasional accidents; however careful you are they will happen.

719. Did you see guncotton stove No. 1 the day after the accident?—Yes.

720. That was very seriously damaged, was it not?—Yes, quite crushed.

721. It contained a great quantity of cordite, but the cordite was not injured at all?—No, it was not, and I think this explosion, if it does nothing else, it certainly demonstrates the great safety of cordite.

722. At what part of the process do you begin to call it cordite?—I think it is practically safe in the kneading machine; we cannot detonate paste, although we have had a few small accidents in the pressing machines. Sometimes the cordite explodes as it comes out, but we have never been successful in our attempts to detonate it. The risk attaching to cordite is, I think, entirely a fire risk, but then you get an intense flame; of course that bears upon the question of rapidity of escape, and the number of persons at work in one place. I think there ought always to be a chance of escape without having to pass a large quantity of the material.

723. *Sir F. Abel.* With regard to the skimmer, when the water has been cleared off this warm nitro-glycerine, do you think there is a danger of possible explosion if a man let a skimmer come down with a run on to the nitro-glycerine?—I think there might be danger, not so much on the surface, but with regard to the skimmer striking the bottom or sides of the tank.

724. *Colonel Majendie.* Were you able to ascertain, during your visit to Waltham, whether anything of the kind had happened?—No.

725. Do you know that one of the men killed was the master plumber?—Yes.

726. Have you heard any explanation given of why he was there?—No, but I ascertained that when things had been repaired there was always an inspection by the foreman before work was started again.

727. Might a repair, such as the renewing of an air-pipe, be carried out in such a way as, in your opinion, to increase the normal risk of the manufacture?—Yes, I think so; if the pipe is made a little short and rests only just on the bottom of the tank, then the force of the air going through it would make it vibrate.

728. If the pipe were not accurately fitted to the tube might not that be a cause of friction and vibration?—Yes, especially if the holes had been reduced by the plumber they would cause the air to go out at a higher pressure.

729. *Major-General Lloyd.* Have you seen any other nitro-glycerine works besides those at Waltham?—Yes, I have seen the works at Ardeer and at Pembrey.

730. With regard to the several points of danger which have suggested themselves to you, can you say

whether they were likely to arise in other works besides those at Waltham?—When I was at Ardeer, they washed with cold water, and I believe that washing with hot water introduces great danger.

731. Does it facilitate the process of manufacture at all?—Yes, there is a larger output in a given time.

732. Will you state what you consider to be the safe limits of temperature for the manufacture of nitro-glycerine in the washing process?—I should not like to go above 26 degrees centigrade.

733. Is there any difficulty in keeping it down below that?—No, I think not; I think the water ought never to exceed that temperature.

734. Have you ever had an opportunity of expressing your opinion of the details of manufacture as carried out at Waltham?—No, I have never been asked for an opinion upon the subject.

735. Would it be any part of your business to make suggestions upon that point?—No.

736. From your knowledge of the place, and from what you have seen of the process, can you now make any suggestions with a view to reducing the danger of the manufacture carried on at Waltham?—I should, first of all, reduce the temperature, then I would make sure that the air pipe is not lying loosely on the bottom or against the side of the tub, and I would exclude all extraneous nitro-glycerine; in fact, I would do away with all the danger attaching to the five points to which I have called your attention.

737. With regard to the chemical changes which might possibly result in spontaneous ignition of nitro-glycerine, is it not impossible that the nitro-glycerine in the store, or any part of it, should have been in such a state of decomposition as to produce spontaneous combustion?—That could not have happened with pure nitro-glycerine.

738. Those chemical changes which take place in nitro-glycerine, from the presence in it of some extraneous matter, or excess of acid, or whatever it may be, would not they disappear in the course of time without combustion and leave only pure cordite?—Yes, some disappear in time.

739. Had you any opportunity of taking a sample of some of the same batch of nitro-glycerine as that which exploded in the store?—No.

740. Then you do not know whether that was pure?—No, I only judge from past experience; testing the finished cordite, which was always good, and I have tested very many samples.

741. *Sir F. Abel.* When you were there, did you see the book of heat tests?—I have seen it, but I did not see it when I was there lately.

742. Were not those tests usually satisfactory?—Yes.

743. Would you expect that any sample of nitro-glycerine which answered to such results would be liable to spontaneous ignition?—No.

744. *Colonel Majendie.* What test of temperature would you apply to nitro-glycerine?—160 degrees Fahrenheit.

745. Is it not a fact that at Waltham the heat test is 180 degrees?—Yes, that was done according to my suggestion. I am bound by the Home Office regulations, or I should like to go higher.

746. You have no doubt that the material you get at 160 is pure material?—That is so.

747. And if it is tested at a higher heat it is equally pure, if not better?—It is better.

748. *Major-General Lloyd.* You say that if the washing were done at a lower temperature it would result in a smaller output; but how would the temperature affect the output?—Now, the whole washing is done in about 1½ hours, and perhaps it would then take 3 hours.

749. *Colonel Majendie.* Looking over some notes of a recent inspection at Ardeer, I find that if nitro-glycerine is put warm on to nitro-cotton it does not always sink into it, but gelatinizes on the outside, and leaves gelatinized claws; that would not be a difficulty at Waltham, would it, because the gelatinization is there effected rather by acetone than otherwise?—That is so.

(*The witness withdrew.*)

Dr. W. Kellner, F.I.C., F.C.S., *examined.*

750. *The Chairman.* You are Chemist to the War Office, I believe?—Yes.

751. *Colonel Majendie.* Have you had occasion to visit Waltham since the explosion?—No. Two days ago I was asked to go there, but I have not yet been.

752. You know, I presume, that one of the houses involved in the explosion was the washing house?—Yes.

753. Are you familiar with the process of washing carried on in that house?—I have not seen it actually done there.

754. Would you regard the operation of washing nitro-glycerine as necessarily a dangerous one?—No.

755. Would there be any details which might be so affected as to constitute a danger; for instance, take the case of the temperature?—Yes, I should say the more the temperature is raised the more danger there would be in the process.

756. Would the material be more highly sensitive when warm?—Yes.

757. Say at 50 degrees centigrade?—It would be very sensitive then to mechanical danger, and a certain amount of friction, which would not ordinarily explode nitro-glycerine, would tend to explode it then.

758. Does any of the material produced at Waltham come before you for examination?—No.

759. Are you in any way responsible for the character of the material or the ingredients?—No. I have had something to do with the drawing up of the specifications for cordite, but nothing in connection with nitro-glycerine.

760. It appears to have been the practice at Waltham to leave the nitro-glycerine, after it was washed, to stand for a certain time, a day or so perhaps, in tanks in the store (one of the exploded houses), and then to place it in the cotton. It has been suggested that perhaps that intermediate time might be dispensed with, and the material put forthwith into the nitro-cotton, so as to get rid of an accumulation of nitro-glycerine by itself, do you think such an arrangement would be attended by any risk to the cordite?—I think not. The practicability, or otherwise, of mixing the nitro-glycerine with the guncotton immediately after it is crushed may depend on the degree of dryness of the nitro-glycerine. It may be necessary to let the nitro-glycerine stand in order to separate the water.

761. *Sir F. Abel.* That is stated to be the object of keeping it, it is also stated that it contains about ½ per cent. of water, and that it is desirable that should subside?—I think that as the guncotton contains more than 1 per cent., it cannot matter about the ½ per cent. in the nitro-glycerine.

762. You have had some experience of the manufacture of cordite upon a small scale, I believe?—Yes.

763. You therefore speak as an authority as regards cordite?—Yes

764. And no doubt you will remember that no special precaution of that kind was taken in our experimental manufacture to get rid of the water?—No, in fact what nitro-glycerine we had available for these experiments was separated on a small scale from old samples of dynamite and other odds and ends by washing with water.

765. *Colonel Majendie.* But you never considered the question of the percentage of water necessarily?—No; the solvent which is used in making cordite is mixable with water, and the latter would thus be eliminated from the cordite dough.

766. *Sir F. Abel.* And the acid is itself not anhydrous?—No.

767. *Colonel Majendie.* Have you considered the question of the utilization of the nitro-glycerine which was in the nitrating house at the time of the explosion, and which has since been washed by hand?—I think it would be just as well not to use that nitro-glycerine, as it was washed by means, other than those usually employed; I think there is an element of doubt about it, although perhaps the doubt is only a sentimental matter.

768. Is not the aëration which is effected rather a material point in the purification of nitro-glycerine?—Yes; but the best means of ascertaining whether nitro-glycerine is properly washed is the heat test.

769. Do you think if it stands the heat test that it is unlikely to contain anything which in process of time would develop bad effects?—I think it is unlikely to do that.

770. But on the whole you are disposed to think that it would be better not to use that rescued nitro-glycerine?—I think so.

771. Would you be disposed to express yourself confidently one way or the other?—I think I should ask for a sample before giving a definite opinion.

772. Do you think 50 degrees centigrade is a high temperature to which to heat the nitro-glycerine?—Yes.

773. Higher than is necessary?—I think nitro-glycerine can be washed without raising the temperature at all, though it takes longer, and then the nitro-glycerine does not separate so quickly. I should take the maximum atmospheric temperature in this country, about 80 degrees Fahrenheit, or 27 degrees centigrade, as the limit.

774. *Sir F. Abel.* Have you tested a large number of samples of the cordite produced at Waltham for stability?—Yes.

775. Have you come across any sample which gave any indication of instability?—No, the stability is far beyond the requirements of the specification

776. *Colonel Majendie.* What test do you apply?—Practically the same as for guncotton, but the temperature is different; the temperature for cordite is 180 degrees and 15 minutes.

(*The witness withdrew.*)

FRIDAY, 25TH MAY, 1894.

Present.

Lord SANDHURST, *Chairman.*

Members.

Sir F. A. ABEL, Bart., K.C.B.
Major-General F. T. LLOYD, C.B.
Colonel MAJENDIE, C.B.

Mr. P. H. BRADE, *Secretary.*

Mr. GEORGE MCROBERTS, *examined.*

777. *Sir F. Abel.* You were formerly the manager at Nobel's Explosives Factory, I believe?—Yes, for about 19 years.

778. Did you not take up the position of manager when the works were first started?—I was there when they first started, and when the first charge of nitro-glycerine was made

779. In elaborating the manufacture of nitro-glycerine at Ardeer, had you not, in the first instance, many difficulties and risks to overcome?—Yes, the manufacture was entirely new.

780. And those difficulties, I understand, related not merely to the processes themselves, but also to the quality of the materials to be employed?—Certainly.

781. But eventually you succeeded in determining satisfactorily the quality of the materials which should be used in the manufacture?—Yes.

782. Had you, for one thing, difficulties in regard to the glycerine used?—Yes, it was so difficult to get it of a pure quality. It was often so impure as to lead to dangerous results.

783. Was that generally the case in the first few years of your experience?—Yes, often we had to drown quantities of nitro-glycerine to prevent explosions, but there is no difficulty in working it now.

784. Was the specification that was adopted at Waltham in regard to the glycerine to be used submitted to you?—Yes.

785. Do you consider that that specification secures the proper quality of glycerine?—Yes.

786. And a quality of glycerine which would not be likely, unless under very exceptional conditions, to lead to dangerous results in the production of nitro-glycerine?—Yes.

787. Were you consulted in regard to the works at Waltham?—Yes.

788. Were the plans of the establishment generally submitted to you?—Not all. I found, when I went

there, that they had already got a plant from Germany, but I soon saw that there were some things about it which were not quite in accordance with the best founded views upon such matters; but, rather than put the Government to the expense of new plant, I told them how to fit up what they had got.

789. Was that plant subsequently considerably modified?—Yes.

790. Was it made to approximate to the Ardeer plant?—Yes.

791. When the plant which was arranged under your supervision was completed, were you satisfied with its probable efficiency?—I was thoroughly satisfied with it. The apparatus at Waltham was intended to deal with only some 200 lb. of glycerine at one operation, whereas the apparatus at Ardeer was intended to deal with 800 lb. or 900 lb.

792. Do you mean that the plant approved of by you dealt with only 200 lb. of glycerine?—Yes, they may have altered it since.

793. I believe you are acquainted with Mr. Thomson, the manager of the Waltham works?—Yes.

794. Was it not upon your recommendation that he was appointed there?—Yes.

795. Is he a trained and skilled chemist?—Yes. At Ardeer he was what we call the relieving chemist; that is, he relieved the chemist whose duty it was to superintend.

796. Have you visited the Waltham works since they have been in operation?—Yes, I went there only once.

797. With regard to the initial washing process, can you point out any serious danger existing in carrying out that process, assuming, to start with, that you have ingredients of a thoroughly good quality used in the manufacture?—I cannot conceive of any danger in the washing; we have washed with water at a temperature as high as 100 degrees centigrade.

798. And may we take it that you did not find that high temperature interfere prejudicially either with the safety of the process or the quality of the product?—Never.

799. Is there, in your opinion, any point connected with the washing process which, if imperfectly carried out by an inexperienced man, might possibly give rise to danger?—I cannot conceive of any; in the initial or pre-washing, there might be, but not in the final washing.

800. Take, for instance, a defective supply of air, or an accidental cessation in the supply of air, would that be likely to lead to any dangerous result?—No, but at Ardeer I had a plan of getting over that by means of a churn staff, and when the supply of air failed, I could use the churn staff in perhaps 5 minutes.

801. Would that be quite sufficient to keep the material in proper motion until the air-supply was resumed?—Quite.

802. Would it have been, in an extreme case, sufficient to ensure efficient washing of the material?—Sometimes. I recollect once, in churning, that a churn staff, weighted with lead, got slung up to the top, near the pulley, and in doing that the rope got broken with a loud crack. The men all ran away, thinking there had been an explosion; I ran after them and said, "You fools, you may be sure that it is all right; what you have to fear is an explosion you will not hear." As a matter of fact, we never hear anything at all in a fatal explosion.

803. When you say that, practically, you cannot put your finger upon any part of the process, or any portion of the operation in the washing process, the imperfect carrying out of which might lead to dangerous results, does that refer to every single part of the process?—Yes, every part of it. I cannot conceive of any circumstance in which an explosion could occur in the final washing.

804. Would you, therefore, consider that the washing process might be entrusted to the hands of inexperienced men?—So far as the safety of the thing is concerned, that might be done, but I always had experienced men there to draw the samples to make sure that the washing was properly done.

805. You think that all the mechanical processes were of the simplest nature and could be trusted to an inexperienced man, provided he was a careful and steady man?—Quite so.

806. In connection with the manufacture of nitro-glycerine, as carried out at Ardeer, do you think, as a general rule, that it is advisable to maintain one man, or one set of men at one particular operation, or do you think it a good course to change them about from one part of the process to another?—As a rule, I never did that, I kept the men in the nitro-glycerine department systematically to their work, and they were never changed from that process, until they were quite up to the work in the nitro-glycerine manufacture.

807. Then I gather that you would not consider it desirable or necessary, for instance, to allow a man in the nitrating house to work there for a week, and then transfer him to the washing house for a week?—Not unless the man was previously thoroughly trained in all the operations. I did it this way, I kept a man at each particular house for a certain time until he knew the whole thing well and could do it so mechanically that he could not make a blunder if he tried; he knew only one way of doing the work. After that I put them to the other houses, and I had to do that because the men thought the final washing was the better work, and therefore I had to give them changes.

808. Did you introduce the use of the taps in the washing houses?—Yes.

809. Are you satisfied with these taps as being thoroughly safe arrangements?—I never knew of any accident with them. I have seen thousands of tons of nitro-glycerine run through them, and I think they are perfectly safe.

810. Is there any liability of the tap becoming more or less fixed in position, so that some force is required to move it?—No, the taps are very easy to turn, and they do not readily stick.

811. Not even if the interior portion of the tap becomes expanded by warmth?—I have known taps get tight, but when they did that we put cloths soaked in warm water on them.

812. Would that be the case, not merely in cold and frosty weather, but also in warm weather, should they happen to stick?—Yes.

813. In that way you would raise the temperature of the tap throughout so that there would be no chance of its jamming?—That is so, the outside of the tap would expand, and then it would open quite easily. In winter time, when the nitro-glycerine was frozen, we always used warmed cloths for the taps, and I never in all my experience knew an accident to happen.

814. How did you remove the soda-water from off the nitro-glycerine in the final washing tank?—There was a tap placed above the level of the nitro-glycerine, by which the wash water could be drawn off, leaving the nitro-glycerine at the bottom.

815. Would that tap be placed close to the surface of the nitro-glycerine?—Yes.

816. Did you use any mechanical apparatus for skimming the water from the surface?—No, nothing at all; it went away by itself gradually.

817. Have you any knowledge of the ladle, or skimmer arrangement, that is now in use at Ardeer; that is, a cup-shaped shallow vessel of lead, with a broad rim, which is lowered down to the surface of the water by means of a cord run through a pulley overhead, the water being run off by means of an indiarubber tube, which goes from the bottom of the skimmer to a hole in the side of the tank fitted with a tap?—I have not seen such a thing as that.

818. It is suspended from the pulley and is governed by the hand of the man using it; is that an arrangement which altogether commends itself to you on the score of safety?—It is rather complicated.

819. It swings freely from the cord through the pulley?—It might give rise to some trouble.

820. Supposing by any chance it got a push and swung from side to side, do you think any danger would result from its striking the sides of the tank?—That weighty thing might produce an explosion if it knocked

against the side of the tank, but that is not very likely, though I have, in experiments, more than once exploded nitro-glycerine with lead upon lead,

821. *Colonel Majendie.* With cold or warm nitro-glycerine?—Cold

822. Warm would be rather more sensitive, would it not?—Yes, I did once suggest a syphon apparatus for drawing the water off the nitro-glycerine.

823. *Sir F. Abel.* With regard to the arrangements carried out by you in the washing houses at Ardeer, did you allow any nitro-glycerine, other than that contained in the washing tanks, to be in the buildings?—None whatever. The fact is, we were limited to 1 ton of dynamite, or 16 cwt. of nitro-glycerine, and, consequently, there was never more than one charge of nitro-glycerine in a washing house at one time.

824. What did you do with the nitro-glycerine you got from the gutters and channels, and the nitro-glycerine you got from the wash waters?—It was washed every day and drawn off. There was a receptacle for that, a wash-water tank as we called it; all the stuff from the gutters and the drainage tanks was run there, and every morning the water was drawn off the wash-water tank, and the nitro-glycerine was taken and washed in C house, that is the final washing house.

825. Was it washed in the same room where the ordinary washing was carried out?—Yes, but it was washed by itself before the other operations commenced.

826. Was it washed in the vessels ordinarily used for the final washings?—Yes, the same vessels.

827. What was done with it afterwards?—It was run down to the store tank where it was weighed off.

828. *Colonel Majendie.* Did you ever have any accident in your wash-water tank with what we may call refuse nitro-glycerine?—No, never. The method we followed at Ardeer was what we call the direct separation; the nitro-glycerine was accessible, and could be skimmed off, and there was always plenty of acid to cool a charge if there was any development of danger. But at Waltham the acid was run off into one tank, and the nitro-glycerine into another; that was dangerous, because the decomposition that might take place in the nitro-glycerine after the acid is run off could not be controlled; I, therefore, recommended a direct separation tank. At Ardeer the first explosion was caused by that very fact of running the acid off and leaving the nitro-glycerine without the means of dilution. I recollect another accident which happened in 1874, when the pond, containing about 3 tons of nitro-glycerine, blew up. I was within 60 feet of the place when it exploded, and I was covered with sand, and there were two men washing a tubfull of nitro-glycerine at the edge of the pond the very moment it exploded; the tub was broken into staves, and the nitro-glycerine was scattered all round, but it was not exploded at all.

829. *Sir F. Abel.* In regard to what you have said about that tub of nitro-glycerine, and recalling to your mind what happened in the explosion at Waltham, do you consider that nitro-glycerine in a building 65 yards distant from the one which first exploded would be likely to be exploded sympathetically?—That would be simply impossible; it could not be; if it exploded at all it must have been by some direct contact.

830. The only chance of communication from the nitro-glycerine detonated at one end would be, if such a thing were possible, through the gutter?—If such was the case that would have caused the second explosion.

831. *Colonel Majendie.* The destruction of the house itself by means of concussion would have exploded the stuff inside, would it not?—Yes.

832. *Sir F. Abel.* After the nitro-glycerine is finally washed at Ardeer, what is done with it? does it go into store tanks?—No, it was not kept at all; we were not allowed to store nitro-glycerine except for a single night.

833. It passes at once to the house, where it is mixed with kieselguhr?—Yes; we did not keep more than one charge overnight in the store tank, 16 cwt. at the most, and in the morning that was used up at once.

834. *Colonel Majendie.* I think it was a condition in your license, was it not, that no nitro-glycerine should be manufactured except for immediate conversion into dynamite or some other explosive?—Yes.

835. *Sir F. Abel.* That necessitated your converting nitro-glycerine into dynamite before the final heat-test had been used, did it not?—Yes, but we had a preliminary test with litmus paper.

836. Your confidence in your process of manufacture was such that if it answered to that test you felt sure it would answer to the more delicate test subsequently applied?—At first it was difficult to get it to pass even that preliminary test, but we got it to do so by subsequent washings.

837. Do you remember what the heat test was, to which nitro-glycerine was subjected, in your time?—70 degrees centigrade for 10 minutes.

838. *Colonel Majendie.* You spoke just now of difficulties and risks in the early days, did those risks disclose themselves in the washing house or was it in the nitrating or pre-washing house?—They disclosed themselves in the separators and in the A and B houses, the nitrating and pre-washing houses, but not in the final washing house.

839. May we take it that no risks appeared even in those days in the final washing house?—None whatever.

840. You did not keep any nitro-glycerine more than a single charge for any time, but, from your own general knowledge and experience of nitro-glycerine, would you consider that there would be any risk in a quantity of purified nitro-glycerine being kept in a locked-up house when there was nobody in that house?—Not the slightest; I have kept it in sample bottles for years.

841. Having regard to that fact, and to the fact that on this occasion two houses exploded, the final washing house and the nitro.glycerine store, are you able to say which would be more or less dangerous, or more or less likely to explode than the other?—I cannot think that the one would be affected by the other, there must have been something very exceptional about it.

842. Have you ever heard, either at Ardeer or elsewhere, of an explosion in the final washing?—Never, I have often heard of explosions in the pre-washings.

843. Or have you ever heard of a spontaneous explosion of purified nitro-glycerine?—No, never.

844. There have been accidents with impure nitro-glycerine, have there not?—Yes.

845. *Sir F. Abel.* Were the drowning tanks at Ardeer fitted with air pipes?—Yes, there were generally two air pipes, one went along the bottom of the tank which was on a slope of perhaps 5 per cent. fall towards the cock.

846. Was it ever necessary to purify a charge which was thrown into the drowning tank owing to undue heating in the nitrating tank?—Yes, perhaps once a week in the early days.

847. Had you any difficulty in purifying the nitro-glycerine in the drowning tank, to the same extent as it was purified in the final washing process?—Generally speaking, the nitro-glycerine got its first washing in the drowning tank and then its final washing in the other house.

848. Would you consider it possible, or easy, to purify a quantity of nitro-glycerine that would be passed into the drowning tank in that vessel itself?—That would not be very easy, it might be done, but you would require enormous quantities of water, because the bottom of the tank would be a very large surface. It could be done, but you would require a great deal of air.

849. Can you say whether the drowning tanks at Waltham were fitted with air pipes?—I was told that they were. I was consulted by Colonel Noble upon the subject of the plant, and I wrote him a series of letters, in which I recommended air pipes in all the nitro-glycerine tanks.

850. *Colonel Majendie.* I suppose at Ardeer you used to observe all the usual precautions proper for danger buildings in the nitro-glycerine buildings?—Yes, there were special shoes and special clothes, and

the men were searched every time they passed the barrier. That was never omitted.

851. Every man was searched?—Yes.

852. How often were they searched in the day?—Three times.

853. *Sir F. Abel.* Do you allow the use of earthenware or glass vessels in the nitrating or washing houses?—Yes; washing the chemicals was all done in glass vessels. My experience is that no apparatus is, in itself, dangerous when you are making nitro-glycerine; you can make it in all sorts of apparatus, provided you know the conditions to be observed. I have seen it made in a jug and in a washing basin. It used to be made in a leaden pot standing in a stream of water, and with a thermometer for testing. If you understand the thing, you can make it easily.

854. Of what did the floors of your houses consist?—The ground floor was all of sand. The platforms were of wood.

855. *Major-General Lloyd.* Can you tell us the nature of the risks in the first washing as compared with the last washing; are they chemical or mechanical?—Chemical. The nitro-glycerine is very full of acid, and a slight increase of temperature may set up a chemical reaction, which will go on until the nitro-glycerine gets into such a state as to explode. The wash houses are provided with thermometers for the purpose of testing the temperature. The man at the tank has one of these thermometers in his hand, and, directly he discovers that the temperature is rising, he turns on the cold air. If, in the operation of skimming the nitro-glycerine, the surface gives off red fumes, the skimming is stopped, the air turned on, and the contents of the tank thoroughly agitated until the stuff is cooled; that is to get rid of the local danger. We have had our glycerine in the early days full of Epsom salts and oil, and resin and lime.

856. After that pre-washing the nitro-glycerine is in a comparatively harmless condition?—Yes, it is pretty safe after the pre-washing.

857. With regard to the leaden pipe lying at the bottom of the tank, it has been suggested that, owing to vibration it might strike against the bottom of the tank, and so be a source of danger. Do you agree with that?—It might cause an explosion if only a thin coating of nitro-glycerine were in the tank, but it could never do that if the tank were full. There would be too much stuff present to get up any rise of temperature.

858. Then it would not be from percussion of the lead pipe, but from a rise of the temperature due to friction that an explosion would occur, if it did occur?—Yes, but even that could not happen if the tank were full.

859. *Sir F. Abel.* Supposing the man in charge of the washing were to allow a large quantity of soda-solution at a temperature of 70 degrees centigrade to pass into the vessel, thus causing a rise in the temperature of the nitro-glycerine considerably above the normal, would that, in the final washing, be any probable source of danger?—No, I have, at Ardeer, washed with a solution between 70 and 100 degrees.

860. With a considerable quantity of nitro-glycerine?—With a large quantity; we get rid of the remaining acid much more quickly if the solution is hot.

861. If, by the heat test, the standard of purity of the nitro-glycerine were considerably raised, as has been done lately, would you consider that the use of the higher temperature, in order to attain that result with comparative rapidity, would be a source of danger?—No, it would not; you see, although the soda-solution is at 70 degrees when it comes down, yet it instantly becomes less when it mixes with the nitro-glycerine, and, in that way, you get a lower average temperature. I have myself tried it, with a boiling solution of soda, and it answered, and it washed very quickly.

862. What would probably be the temperature of the nitro-glycerine when you used a soda-solution of 100 degrees?—About 60; of course that was only experimental, but I washed at that temperature for some time when we were trying to meet the requirements of the Government test.

(*The witness withdrew.*)

[Note.—Mr. McRoberts subsequently sent to the Secretary a memorandum containing his opinion relative to certain matters not alluded to in his examination, *see* Appendix XIII.]

Mr. Oscar Guttmann, *examined.*

863. *Sir F. Abel.* Have you had considerable practical experience in the manufacture of nitro-glycerine?—Yes, for the last 20 years.

864. Where did you acquire your experience before coming to this country?—In Austria, Switzerland, and in Italy. I was Nobel's chief manager in Switzerland and Italy. I have visited a great many of the explosives factories that exist.

865. Had you visited the works at Waltham previous to the explosion of the 7th of May?—Yes, several times.

866. Did you observe the general arrangements?—Yes.

867. Was there any point in connection with those arrangements which struck you as being exceptional as compared with those which existed in other factories?—There were, no doubt, many points.

868. Did any of those points bear upon the safety of the manufacture of the material?—Yes; for instance, there was the too close proximity of the washing house to the nitrating house, and yet, when I was there the day before yesterday, I found that they were rebuilding the washing house in the same place; to my mind, that is dangerous.

869. That is a matter connected with the general arrangements of the works, and it may, to some extent, be governed imperatively by the particular locality of those works?—I see no reason why they should not be altered, there is room. I was asked by the Superintendent of the Royal Gunpowder Factory to look into the question of the last explosion of the pond; and on the 19th of April in this year I sent him a communication in which I dwelt upon the unsuitability of the present system of washing. I also told him that the arrangements in the waste-water house for collecting the waste water and separating the nitro-glycerine from it, were not, I thought, satisfactory. At his request, I sent him a plan of what I considered would be a proper arrangement, and he then sent Captain Nathan to the National Explosives Company's factory at Hayle, to see the particular apparatus which I suggested at work.

870. In what particular respect did you find the arrangements in the washing house unsatisfactory?—In the first place I objected to their washing nitro-glycerine at a temperature of 50 degrees centigrade. When I first went into the washing house I noticed that it was full of nitro-glycerine vapours. I said to Mr. Thomson,

"can you tell me the temperature at which you are working," and he said "about 30 degrees." I said "that would be hardly the case." I then dipped my hand into the tank, and I said "this is at least 50 degrees centigrade," and it was. Washing at that high temperature is, in my opinion, wholly unnecessary, and is certainly not safe, because the nitro-glycerine gets into such a state of sensibility that the least inattention on the part of the workmen may render it dangerous.

871. *Colonel Majendie.* That is a mechanical and not a chemical risk?—Quite so. There is another mechanical risk, this vaporized nitro-glycerine is bound to condense somewhere, and most probably that would be on the windows or skylights, and it constitutes a danger. I called attention to those points when I was there. When at Waltham in the cordite case it was stated by somebody that it was impossible to evaporate nitro-glycerine to a great extent, but I maintained that I could evaporate 10 per cent. of nitro-glycerine at 50 degrees centigrade. During my visit to Waltham the day before yesterday I believe that I discovered the exact cause of the last explosion. I believe that it first originated in the washing house, and in that washing tank by the particular arrangement of it. Here is a sketch of the vessel in question (*see* Appendix XI.) and you will notice there is a pipe to which is fastened an india-rubber hose with a leaden funnel or skimmer at the top, and that skimmer is suspended by means of a rope over a pulley, the rope being fastened by means of a turn round a staple on the side of the tank. Now what happened, I think, was this, after the man had skimmed off the stuff he held the rope in his hand, and in trying to fasten it on to that staple, the skimmer either slipped out of his hands or else broke off the pulley, in that way causing the explosion. From that house I think the explosion was communicated to the store house, because I ascertained that on the whole of the channels through which the communications were made were found marks of fusion, indentations of explosion, and marks of the wood, in fact everything to show that the explosion was communicated in that way. A weight of 28 lbs., falling 1 foot on nitro-glycerine, never failed to produce an explosion, and it has been determined exactly that at $5\frac{1}{2}$ foot-lbs., nitro-glycerine explodes between iron and iron. That skimmer weighed 36 lbs. complete, and the height at which it fell would be about 3 feet, or perhaps only about 2 feet; but supposing it fell only 2 feet, that would give about 72 foot-lbs.

872. When would it be only 2 feet?—There would be one-third nitro-glycerine, one-third water, and the other one-third would be left open to allow for the froth which arises on the material being stirred with air. The man might therefore have skimmed off the second foot, and then in lifting the skimmer up he would have to lift it up above the level of the water, and in trying to fix the cord to the staple, the skimmer would be more than 2 feet high, the outside distance being 2 feet $7\frac{1}{2}$ inches.

873. And are you of opinion that such a weight as that, falling from that height, would cause an explosion?—I am of opinion in that way decidedly, if it would not invariably produce an explosion it would do so under unfavourable circumstances.

874. Would you regard the warm condition of the nitro-glycerine as an unfavourable circumstance?—Yes, decidedly; I should say warm nitro-glycerine getting a blow of 72 foot-lbs. of lead upon lead, or even wood upon wood, would explode. May I furthermore point out that there was no earthly reason for this complicated piece of machinery called the skimmer.

875. That existed at the time of your visit to the factory?—Yes.

876. Were you dissatisfied with it from the point of view of want of safety or inconvenience?—I did not go into the question of safety; I did not consider that my duty; all I was asked to do was to consider the question of how the nitro-glycerine came into that pond. When a man held that skimmer by means of the rope it would have to be below the water to catch the water, and when he came to the dividing line between the nitro-glycerine and the water, he would have to balance the skimmer very well indeed, in order to get out only the water and no nitro-glycerine; in fact, he could not do it. I believe the men were somewhat under the impression that it did not matter whether they took up some of the nitro-glycerine with the water, because, after all, it went to the pond, where it was destroyed. That would happen even when the men were careful; but suppose a man was not careful, then a large quantity of nitro-glycerine would escape, and if this 36 lbs. of lead slipped down, from the pulley-cord being let go, then an explosion must occur. But there is really no necessity whatsoever for this complicated machinery. They are dealing with one tub, with a charge of about 750 lbs. of nitro-glycerine, they know to a quarter of an inch where the level of the nitro-glycerine will be, and in my letter I say with regard to that, "Since you are dealing with very nearly the same quantities of nitro-glycerine in your washing tanks at each operation; that is to say, with one or two charges at a time, there is, in my opinion, no difficulty in placing a tap at about an inch above the maximum level of the nitro-glycerine, and drawing off the water by means of the tap after each washing."

877. *Sir F. Abel.* Have you seen such a side tap arrangement in operation?—Yes, in my own works, and in other places. If I may say so, I should think that tank at Waltham was somebody's "fad." It is, mechanically, quite nice, and a very ingenious arrangement for removing by very difficult means what is, after all, only a small difficulty.

878. Then, do you consider the method of manipulation crude?—Yes.

879. *Colonel Majendie.* But, commercially, it is defective, inasmuch as it is likely to lead to a greater loss of nitro-glycerine than is necessary?—Yes, I think so.

880. So your main objection is rather with reference to the question of safety?—Yes, that is my main objection; I think the less you manipulate these things the better. I think the filter through which they filter the nitro-glycerine is an unnecessarily complicated thing; it could be done with the greatest simplicity with a piece of flannel on a frame, and probably it would be more effective than it is with the present heavy complicated filter, which gives the men too much work to do in moving things about from one place to another. The less men have to work over these things the better.

881. So far as the operation of washing goes, have you anything to point out which might be altered?—Yes, I think so, though perhaps there may be no serious danger in it, for I am not quite certain what they are doing with regard to the washing. When I was in that waste-water house I asked where the water was coming from that I saw there, for it was extremely yellow, and I could see at once that they were using a very strong soda solution. I asked the man there what amount they were using, and he said it was a soda solution marking 10 degrees Twaddell at 84 degrees Fahrenheit. I calculated that when I got home and found it was very near a 4 per cent. soda solution. I do not for a moment say that that constitutes a danger; in fact, I do not think it does, but certainly a 4 per cent. soda solution is likely to decompose the nitro-glycerine. The man told me they were taking 4 inches of the solution, then adding the nitro-glycerine, and then 4 inches of soda solution, and then a washing for 15 minutes, then they remove the soda solution and put in another 2 inches of soda solution; in fact, they do it inches by inches four times. Captain Nathan, on the other hand, told me the day before yesterday, that that was not the case. He said the soda solution in the first case was 2·68 per cent. for 15 minutes, then 1·91 per cent. for a second 15 minutes, then 1·91 per cent. for 45 minutes, and then ·38 per cent. for another 15 minutes. However, the result of the whole thing shows me this, that in order to remove the small trace of acidity which may be left they are constantly using a soda solution of from $2\frac{1}{2}$ per cent. down to about $\frac{1}{2}$ per cent. That, I think, is unnecessary in

the first place, and in the second place, as I say in my letter, "Although the prolonged treatment with this soda solution may ultimately leave sufficient soda in the nitro-glycerine to make it pass the heat test when newly made, I have no doubt, from my own experience, that if you were to take a drop of nitro-glycerine from such washing, with a small particle of soda mud or sulphate adhering to it, put it on a watch glass and add a drop of distilled water, you would find that on testing this with methyl orange, or congo red, it would show an acid reaction, due to the decomposition of the nitro-glycerine by the soda. I have also no doubt that after some months the soda will have disappeared from the nitro-glycerine, and the latter will not stand the heat test as well as when freshly made."

882. *Sir F. Abel.* You know, I suppose, that in the successive washings they apply the litmus test?—Yes.

883. And, therefore, when it leaves the washing house it is supposed by the litmus test to be pure, although it has not undergone the heat test?—That is so, and that, I think, corroborates what I have said that there are only the minutest traces of acidity in that nitro-glycerine, which does not require a small bulk of strong soda solution; what is wanted is a large quantity of slightly alkaline or pure water in order that every particle of the nitro-glycerine shall be brought into contact with the washing liquid.

884. Are you of opinion that aëration is of equal importance with the employment of alkaline?—Yes, I think so. I have tried to find out the absolute effect of both cold and warm aëration on nitro-glycerine, but I have not yet been able to arrive at a definite conclusion upon the point. There is no difficulty in making the nitro-glycerine stand the heat test after any length of time provided the nitro-glycerine is made at the outset absolutely neutral with all the traces of soda washed out of it by means of water.

885. What you have been pointing out in that is of importance with regard to the commercial product, but do you think it bears upon any possible source of danger in producing the nitro-glycerine?—No; I do not pretend that the solution of 4 per cent. would have any immediate danger except when alcohol is added.

886. *Colonel Majendie.* Do I understand that this ultimate decomposition could in your judgment have declared itself in the nitro-glycerine in the store which had been there only a day or two?—I think it would show itself only after a year or so. I do not think the explosion could have happened in the store to begin with, I think the explosion was communicated from the washing house to the store by means of the channels. There was a sort of housing which went along from one house to another and that contained a V-shaped leaden gutter covered over with wood, the whole thing resting on wooden supports standing about 18 inches apart.

887. What evidence of an explosive effect did you observe in connection with the gutter or housing?—When I asked Colonel McClintock and Captain Nathan, they said they did not see any marks of burning; however, I was not satisfied with that, so I got some of the pieces of the gutter (which had been cut up), and I looked over them with Captain Nathan and the plumber, and I found that the V-shaped channel, which is bent to an angle of about 60 degrees, was perfectly flattened out. [The witness then explained to the Committee the effect of the explosion upon the V-shaped channel.] In many instances we could find on the reverse side of the channel the imprint of the grain of the wood, and that would be one of the effects of an explosion. There were also local indentations here and there, as if trains of nitro-glycerine had exploded on the lead, and those indentations were fused, but not deeply, although you could see the rough surface as if the lead had become molten. The whole of the housing was thrown down. That would be the case when small quantities of nitro-glycerine would be running along the gutter and exploding; and, not having sufficient force to destroy the housing, but sufficient to throw the housing over. There was no nitro-glycerine running in the gutter at the time; but, on account of the fall, 1 in 26, there would be always a little stream of nitro-glycerine lodging there which would be just about sufficient to communicate an explosion from one house to the other.

888. *Sir F. Abel.* Provided it was continuous; but what you have pointed out hardly appears to me to indicate a continuous layer of nitro-glycerine?—I think it does, because where it was supported by the wood, the indentations would not be so deep as in the other places.

889. *Colonel Majendie.* Might not the effects upon that channel have been produced by an air wave?—No, I think not, because the channel was covered and housed.

890. Yes, but there was of course an enormous atmospheric disturbance established by the first explosion which would press into and down that channel, would it not?—Part of it might if the openings were open on that side, but that would not cause the lead to be melted; that would also not produce these indentations and it would not flatten out *that* part sideways. The damage being lengthways, the evident marks of a sharp blow, as shown by the grains of the wood at the back, the fusing of the lead, and the throwing down of the whole gutter, these would be the effects of one simultaneous shock running through the whole thing.

891. Are those marks consistent with the effects of a shock delivered by something other than nitro-glycerine?—No.

892. *Sir F. Abel.* What did you see in the way of fusion of lead?—I saw the surface of the gutter.

893. Were there marks throughout its length?—No, only at those points at the bottom where nitro-glycerine was remaining after the general run of it had gone.

894. I think experience indicates that for the transmission of detonation it would be necessary to have, in the case of a liquid, a perfectly continuous train of the explosive material; it would not be likely to jump over any distances beyond minute distances for any great length?—You mean on the ground only, not on a metal surface.

895. Yes, I mean on a metal surface; I do not see where the difference comes in?—I think, in such a channel as this, if there were anything less than 6 inches between the points; I think that would be enough to cause them to explode, but I would not say above 6 inches.

896. I do not think any experiments have been made to prove that?—I am only speaking from memory when I say that I think experiments have been made. They have made experiments in blasting of bridges with regard to that, but I do not know whether they have done anything with liquids. I do not see any reason why the train of nitro-glycerine should have been discontinued.

897. *Colonel Majendie.* The time intervening between the explosions of the two houses, so far as the evidence goes, was at least inappreciable?—There is a man who says he saw the second explosion after he heard the report of the first.

898. Are you referring to the man who states that the nitro-glycerine store went first?—Yes, I believe he is quite wrong. The man may have noticed the smoke on his right, for, by the time he took to get from his desk to the door, the wind would have blown the smoke from left to right; the wind was blowing east to west; that is, from the nitrating house to the store, at the time of the explosion.

899. You have had experience in regard to the construction of danger buildings, I believe?—Yes.

900. Do you approve of mounds or traverses, such as those used in the constructions round the buildings at Waltham?—Yes.

901. Do you approve of mounds round a pit, so to speak, or would you prefer mounds with openings in them?—Mounds with openings in them, even if they are earth mounds; I would never put down mounds with only tunnels or doors in them.

902. Here is a plan of a house [showing the same to the witness], and there are three ways of protecting it, one is to put a mound all round it, another is to cut away a part of the mound, and another (if you cannot afford to have a line of least resistance) is to place an

extra traverse opposite the part you have cut away. With regard to those three ways, have you any choice of one over the others?—I certainly prefer the last with the extra traverse.

903. Are you now considering the question more from the point of view of the escape of the work people?—Yes, because as far as the fate of the building goes, no mound would be any good which was not sufficiently high.

904. *Sir F. Abel.* But, with regard to the building itself, and the crushing-in effect of the air-wave, which plan do you prefer?—Traverses all round, because the explosive wave, if it passed over the building, would not lose its effect if one of the tunnels or doors or sides were open, it would not go down and then up again, it would sweep over the building.

905. *Colonel Majendie.* It would be an undulating wave, would it not?—Yes.

906. And suppose one of the depressions of the wave passed over the house, would it not be more likely to produce the destruction of the house if there were no escape for the air; that is, if the air were in what we may call a *cul de sac*?—I doubt whether the effect of one side being open would make any difference in the pressure on the top.

907. You mean as regards the vacuum effect?—That, perhaps, would be different, and no doubt that effect would be stronger if it were a *cul de sac*.

908. In the case of a powerful explosion, might not that vacuum effect be sufficient to establish the destruction of a wooden house?—I have witnessed several explosions, and I have seen the remains of several explosions, but I have not in any instance seen that vacuum effect except recently at Waltham

909. Have you seen such an effect as this upon a house [showing the witness a photograph]?—Yes.

910. Do you not think that is, in a large degree, fairly indicative of a vacuum effect when I tell you that the windows in that house were swept out with such force that the glass was found sticking in a brick wall, some 12 feet away?—That would be a very strong vacuum effect.

911. Do not you think that a vacuum effect which produced such a result as that would be apt to be intensified by a vertical *cul de sac* traverse?—Yes, I have no doubt about that, and for a vacuum effect that would be an unfavourable plan; but then it would be extremely difficult to always get a line of least resistance, and leave one part of the thing entirely open.

912. But would not that depend upon the character of the place; for instance, at a place like Hayle, am I not right in assuming that you have several mounds which are so arranged as to afford lines of least resistance?—I think in any factory of a large character it would be difficult to have always one side of a place open.

913. But take your own cartridge houses, they are not absolutely embayed in the pits, are they?—No, there are openings in the traverses for the entrance-way; they have wide openings, and they are not enclosed on all sides.

(*The witness withdrew.*)

Mr. LUNDHOLM, *examined.*

914. *The Chairman.* You are the manager at the Ardeer Explosives Factory, I believe?—Yes.

915. *Sir F. Abel.* How long have you had the works there under your charge?—Since 1889.

916. During your term of management have you had any accidents in the manufacture of nitro-glycerine?—Yes, a decomposition in the nitrating vessel, when the mixed acids and nitro-glycerine had almost all run to the separating-house, which we put down to the presence of oily putty, and the ponds have gone off twice since 1887.

917. Have there been any explosions in connection with either the pre-washings or the final washings?—No.

918. *Colonel Majendie* What is about the quantity of nitro-glycerine which has been manufactured under your management and without accident?—About 11,400 tons, since I have been manager.

919. And all that without any accident at all in connection with the final washing?—Yes.

920. *Sir F. Abel.* Had you visited Waltham before the explosion of May 7th?—Yes.

921. Did you know generally the course of operations pursued there?—Yes.

922. Were the arrangements for washing similar to those adopted at Ardeer?—Yes, the only difference being the slightly higher temperature.

923. What temperature have you been in the habit of fixing upon as a maximum?—At one time the soda solution used to be 70 degrees centigrade, now it is only 60 degrees centigrade. That means that by the time it gets to the washing house it is only about 54 or 56 degrees, and when it is in the tank with the water used for cooling the gutter, it is down to about 42 degrees centigrade. The temperature of the mixture of nitro-glycerine and soda together is between 30 and 40 degrees. I have here some figures which show that in the first washing the mixture was 36 degrees, in the second washing 31 degrees, and in the third washing 34 degrees.

924. Had you any reason for reducing the maximum temperature?—We have taken off 10 degrees since the accident at Waltham. We do not think there is any danger in the higher heat, except in so far as it induces greater sensitiveness. During experiments carried out at Ardeer in the presence of Sir F. Abel, Dr. Dupré, and Professor Odling, the temperature of the mixed nitro-glycerine and soda solution was raised to 90 degrees centigrade, in order to prove that heat was not causing the soda solution to decompose the nitro-glycerine.

925. Do you think that the operation of washing is generally a safe one?—Yes.

926. Is there any point in connection with the operation at which heedlessness on the part of the men might lead to danger?—Yes, if a cock sticks and they try to force it, but if you then warm or thaw the cocks they work quite easily.

927. *Colonel Majendie.* You think there is a risk there, but have you known of any case in which such a risk occurred?—Yes, in the house from which the nitro-glycerine goes down to the pond; in that case a cock broke.

928. Was there any explosion?—No.

929. Then you have never had an explosion caused in that way, but you recognize a risk?—Yes.

930. Do you know whether an explosion from such a cause has happened elsewhere?—Yes, at Krummel, where a cock was frozen and the men tried to force it.

931. Was that in the final washing house?—Yes.

932. Have you ever known of any other accident in the final washing house?—Yes, there was one at Schlebusch in 1893, but that happened from lightning.

933. *Sir F. Abel.* Do you remember the arrangement of the skimmer used at Waltham for removing the wash water?—Yes.

934. I believe you were the first to introduce that arrangement?—Yes.

935. What arrangement had you at Ardeer before that?—The men had to bend over the edge of the tank,

press down a bucket in the liquid, and let the spent soda flow over the top into the bucket. The bucket was really dipped into the nitro-glycerine in that way and lifted out of the tank with nitro-glycerine on its outside.

936. *Colonel Majendie.* Was there not a tap fixed in the side of the tank?—We had two taps as we have now, and a bucket in addition; after every washing they had to remove the soda from the tank, and then at the last they let out the nitro-glycerine.

937. Was there not a tap at just about the place where the top edge of the nitro-glycerine came to?—No.

938. When did you introduce the skimmer?—In 1887, I think.

939. Then the quantity of nitro-glycerine, 11,400 tons, that you have mentioned has been manufactured by means of the skimmer?—More than that, because the skimmer was in use before I was appointed manager in 1889, during the time I was assistant.

940. Have you always been satisfied with the skimmer?—I have never had any reason to doubt its safety.

941. Are you using it now?—Yes, in the three nitro-glycerine houses.

942. Do you use it under conditions similar to those which prevailed at Waltham?—Except that our tank is larger; at Waltham the indiarubber tube is shorter, and, therefore, the skimmer is less likely to swing about than it is with us.

943. For that reason do you think the arrangement at Waltham is safer than the arrangement at Ardeer?—Yes

944. Do you, at Ardeer, secure the skimmer by means of a pulley?—Yes.

945. How did they come to adopt that arrangement at Waltham?—Upon Mr. Thomson's suggestion.

946. Then he brought the arrangement with him, so to speak?—Yes.

947. Is there any probability, so far as you know, that the skimmer at Waltham would introduce a risk which does not exist with the skimmer at Ardeer?——No.

948. Have you ever known of a case in which it came down with a run?—It comes over with a slight jerk occasionally, but not with a run; the cord is fastened by taking a turn round a peg, and if the man lets the rope slip on the peg it jerks.

949. *Sir F. Abel.* Supposing a man were careless enough not to take a turn?—I have not seen that, but it might happen.

950. Under those circumstances, it might slip from his hands?—Certainly.

951 *Colonel Majendie.* If it did slip, would it be likely to cause an explosion?—I do not believe it would.

952. Do you believe you cannot explode nitro-glycerine with lead upon lead?—I cannot say that, but the drop is very small and the nitro-glycerine is settling below the soda solution, so that the skimmer would drop on to the latter.

953. But suppose all the soda solution has all been removed, and he dropped the skimmer before he put in the other soda?—Then it must fall down upon the nitro-glycerine, but there would be nothing hard to strike against.

954. *Sir F. Abel.* What would be the minimum depth of nitro-glycerine in the tank?—Perhaps about 30 or 36 inches.

955. *Colonel Majendie.* If the skimmer were to strike the side of the vessel in its fall, would there not be a risk of explosion?—I do not think it is a risk, the vessel is very small in diameter, and I think the india-rubber tube would help to prevent an explosion.

956. You say "the vessel is very small," are you taking into account the fact that the nitro-glycerine would be in a very warm state?—Yes, but it is not very warm, under 40 degrees centigrade.

957. But warm enough to make a sensible increase in its sensitiveness?—Yes, I believe so.

958 I believe you were at Waltham at the time of the explosion?—Yes

959. Did you have an opportunity of making any sort of observations or enquiries, so as to enable you to form an opinion as to the cause of the explosion?—I think it must have been an accident. There were two houses that went. Where men are working in a house you cannot say what they will do or what may happen, but I cannot form any opinion why the house went off where there were no men.

960. Were you able to form an opinion as to which of the houses went first?—Where you have two houses, one of which is supposed to have been left without anybody in it for 25 minutes before the explosion, while, in the other house, work is going on, you are naturally inclined to blame the house where the work is going on if there is no direct evidence pointing the other way.

961. Supposing operations had been going on in the other house, it would not have been a more dangerous house than the washing house, would it?—No, rather less.

962. Did you form any opinion as to why both houses went off?—I think it might have been either by concussion from the air or by concussion from the ground, but I am very doubtful whether any of these agencies caused it. I heard only one explosion; the air wave was very violent and there was no time for any other agency, such as flying débris, to act.

963. *Sir F. Abel.* That would act mechanically to destroy a building, would it not?—Yes.

964. *Colonel Majendie.* That would be dangerous to the nitro-glycerine stored inside the building?—That would be a matter of time, and it seems to me there would not have been time for the air to destroy the house and then send the débris into the house; I heard only one explosion.

965. Are you satisfied with the positions of the houses in regard to one another?—Private factories would not be compelled to have them so widely apart as the distance between the final washing house and the store for nitro-glycerine at Waltham.

966. As a matter of fact, do you, at Ardeer, keep any store of nitro-glycerine beyond what you are engaged upon for manufacturing operations?—No.

967. And you have no stock of nitro-glycerine in a quiescent purified condition?—No.

968. Do you think it desirable to keep a store of that sort?—I do not know; it all depends upon how you have to work a factory.

969. Would you see any objection to premixing the material in nitro-cotton?—No.

970 Would not that be a better condition in which to have it, rather than keep it in a liquid condition?—I think it would be the better way if you want to carry it about, but it may interfere too much with the work of the house.

971. *Sir F. Abel.* Might you not have to keep the nitro-glycerine for some time on account of its warm condition, which creates a difficulty in mixing it with the nitro-cotton?—We did sometimes find that happen, and then we let the cold water in to cool it.

972. *Colonel Majendie.* In those cases you were dealing with soluble cotton and ballistite, too, were you not?—Yes.

973. What is the strength of the soda solutions you use at Ardeer in your first, second, and third washings?—The soda solutions are all of practically one strength, about 5 per cent. The result of an analysis was as follows:—The first was 5·64 per cent., the second 4·74 per cent., and the third 5·68 per cent.

974. Do you know at all whether the strengths used at Waltham are in excess of those?—I think they are generally less; they let a good deal of water down, which we do not.

975. Is there any inconvenience or injurious result likely to arise from having a strong soda solution?—I think not. We used to have greater strengths than those.

976. With those soda solutions I understand you can produce a thoroughly suitable and good nitro-glycerine?—Yes, I have some samples now standing in the laboratory magazine which are 16 or 17 years old.

Here are some results which have just been telegraphed to me. "Six samples nitro-glycerine tested, 1877, very faintly acid stood more than 17 minutes; 1882, neutral stood 14 minutes; January 1883, neutral stood 9 minutes; April 1883, very faintly acid stood 13 minutes; October 1883, neutral stood 10 minutes; December 1883, very faintly acid stood 14 minutes of the vapour test at 82½ degrees centigrade."

977. When you were at Waltham, did you look out the question at all as to whether the explosion could have proceeded from one house to the other by means of the gutter?—Yes, that was the first I examined.

978. What was the conclusion you came to?—The gutter was clean, and heat did not seem to have discoloured it. It did not appear to me to be in the slightest way injured, further than being flattened out.

979. To what do you attribute that flattening?—To the air pressure.

980. Did you observe any fusion whatever in the lead?—No.

981. I gather then you do not think it proceeded by way of the gutter, and therefore was not a transmitted detonation?—It seemed so.

982. Could it have been transmitted if the stream or train of nitro-glycerine had not been continuous; that is, if there were only pools here and there?—I think so, if they were not too far apart, but I do not know where those pools could have been, because I would have expected them to burst the lead if detonated.

983. Supposing there were some little depressions in the lead, would you attribute them to the nitro-glycerine, or what do you think those depressions were liable to be produced by?—Expansion and contraction, because lead, when expanded, does not contract again to the same extent.

984. *Sir F. Abel.* Is not lead, being a non-rigid metal, liable, especially on a slope, to become ridged and to have depressions formed in it spontaneously where the metal surface is not in close contact with a supporting surface?—Yes.

985. *Colonel Majendie.* May we take it, at any rate, that you saw nothing in connection with that gutter which made you believe that the explosion proceeded in that way?—That is so.

986. And you do not believe it did?—No, I do not.

987. Did you observe the construction of the traverses at Waltham?—Yes.

988. Have you any observations to make in regard to them?—They stood much better than I thought they would. I saw the débris from them flying about a good deal, but it did not fly about so much as I should have thought it would. I think it took up a good deal of the lateral pressure.

989. Do you like brick traverses?—No; but I have really had no experience to found that dislike upon.

990. Are you in favour of surrounding houses absolutely with traverses, or would you be in favour of having an open side?—I like an open side or a more sloping top, to give the air more room to develop itself.

991. If you could give a house a line of least resistance, would you prefer to have that on such a site as you found at Waltham?—Yes, certainly I would, if the position of other buildings allowed it.

(*The witness withdrew.*)

Sir B. Baker, K.C.M.G., *examined.*

992. *The Chairman.* You are a scientific and practical engineer, and one of the civilian members of the Ordnance Committee, I believe?—Yes.

993. Have you visited Waltham since the explosion of the 7th May?—Yes, in company of Dr. Anderson and the officers there.

994. *Colonel Majendie.* Have you visited the place with reference especially to the construction or erection of buildings?—I understood that my visit there was to consider the question of the structural damage generally which the buildings had sustained, and to form my own opinion as to the nature and direction of the forces which caused that damage. My experience as an engineer with explosives has, fortunately, been confined chiefly to cases where the amount of explosive used was proportionate to the work to be done, from small charges up to the explosion of 120 tons at Hell Gate, in New York. I have also had a very large experience of the structural damage to buildings arising from tornadoes and cyclonic storms in the United States and in this country; and, therefore, in viewing the damage done to these buildings at Waltham, I had in my mind my previous experience of the results of similar damage done to other buildings, but arising from different causes. It appeared to me at Waltham that there were, practically, three sets of injurious causes. One was the direct blast of almost immeasurable force near the site of the explosion itself, another was the great barometric disturbance arising from the explosion, which, in some cases, caused the crushing down of the roofs of the buildings, and in others an upward movement due to partial vacuum, whilst a third cause of injury to buildings at a distance was the so-called "sound-wave" action. I have seen injuries from the two latter causes after the passage of cyclonic storms in America of much greater extent than at Waltham; and I think the disturbance caused by that great amount of nitro-glycerine was remarkably small, and the variations of atmospheric pressure were much less than in many storms. In the districts of America, such as Kentucky and Illinois, visited by the storms to which I refer, the loss of life from that cause alone is about 102 per year. In regard to the pressure that would cause the damage at Waltham, it seemed to me that the arrangement by which the buildings were sunk in the ground had really the effect of diverting the great force of the explosion upward, and thus accounting for the remarkably small amount of damage laterally. I was once asked, at a meeting of the Ordnance Committee, what pressure per square foot a man could sustain. I said, judging from my experience, I thought that 30 lbs. a square foot was the utmost lateral pressure a man could sustain, even if he knew the direction in which the pressure was coming. I designed some pressure gauges, and it was arranged to put them at different distances from the muzzle of a 6-inch gun, shifting them back until the zone of 30 lbs. pressure was indicated, and with only 15 lbs. of cordite it was remarkable the extent to which that pressure extended. Judging by these experiments, I can only say that if the large amount of nitro-glycerine which exploded at Waltham had had free lateral movement, I hardly know what would have happened. [The witness then described the various results of the experiments with the 6-inch gun, and pointed out that a man 10 feet in advance of the muzzle would have to get 35 feet away laterally, or he would be blown over.] Those results to my mind show that the lateral force at Waltham must have been enormous, and it is difficult to say what the effect of that pressure would have been if it had not been diverted upwards by the traverses. The force of a tornado was measured in a

very interesting way quite recently in America, and it arose through their noticing that some timothy straws were driven about $\frac{3}{8}$ths of an inch into the bark of some trees. Up to that time no one had ever been able to measure what the velocity of a tornado was, but seeing those straws in the trees they made some experiments with them by shooting them out of an air gun, and they found that a velocity of about 200 miles an hour, or 200 lbs. per square foot pressure, was necessary to produce the same results as they got with the tornado, and a much smaller pressure would have caused the injury to most of the buildings at Waltham. In one case of a storm that I know of, a grand piano was sucked up from a building and taken away 270 feet; I also remember a case in which a great barrel full of tar was taken up; and putting all these facts together, I am struck with the enormous amount of protection which those traverses, though weak in themselves, afforded. I say "weak," because if you had filled the space enclosed by them with water the lateral pressure of the water would have thrown them down. The general conclusion I draw from all that is that the important thing to do is to prevent the lateral pressures from getting out; you want to direct the whole of the force of an explosion up into the air, where, relatively, it will not have 1 per cent. of the damaging effect it would have if acting laterally. With regard to the destruction of the buildings themselves, I think that arose from the framework not being strong enough to support the skins. If the skin had been weaker it would have given way, the building would not have been crushed when the wave passed over it, and the pressure would have been equalized by the skin giving way. For instance, if duraline could be used instead of glass (I do not know what effect the acid would have upon it); and if, for example, the roofs and some of the sides of the buildings had been made with that, firmly fastened on one side and weakly fastened on the other, they would simply have opened like flap valves, and the buildings would not have been crushed. As regards the effect upon the men inside, I may say that I have myself experienced something in that way. I was once suddenly exposed to a pressure, not of 30 lbs. to the square foot, but of 1,400 lbs. to the square foot, from the air suddenly bursting into an "air-lock" where I was. I had to think of making my escape, but the physical shock did not attract my attention at all, and, therefore, I am quite certain that any man working within all-round traverses would not be affected in any way, although the actual pressure was strong enough to smash up the building within the traverses. To avoid such a smash you have to make the skin of the building weak, ordinary skylights would give way at about 60 lbs. a square foot, and if the sides of those buildings had been correspondingly weak, I am sure none of the framework would have been damaged, and the pressure would not have affected the men in the smallest degree. I noticed that the telegraph wires were not blown down at Waltham, although they were not very far off from the buildings destroyed.

995. Have you considered the question of the reaction or suction effect of such disturbances?—In all storms the chief source of damage is the suction effect, and it seems to me, by the sketches I have here (*see* Appendix XII.), that there is no provision for that in the new buildings; they seem to me to be likely to go up like balloons. I think the boarding on the sides of the buildings should be arranged like hinged flap valves, so as to give way at once both to suction and to pressure.

996. Do you consider that the effect would be intensified or relieved in any way by the arrangement of traverses?—Yes, I think it might. It has been found that in casemates which are covered in on the top, and where there is a great deal of space round the gun port, there is a wave of suction inside which has to be relieved by making openings in the rear; but where they are not covered in, I do not think that plan has been found so successful. What I wish to make clear is, that I do think that the least harm would arise, from a pressure wave of 200 lbs. to the square foot, passing over one of these buildings if constructed as I suggest.

997. Do you think it would be practicable to construct a house which would not be sensible to that amount of pressure?—Certainly; the real danger is the side blow, and unbalanced not absolute pressure. If there is a wave of pressure and suction like that which destroyed the buildings, and, from the construction of the works, it is diverted laterally, then it is all over with anybody who is in the neighbourhood. The ideal structure would be one in a pit to which the men would have to go down a ladder.

998. Supposing you could get a building with sufficient space at your command, and with a zone round it which you need not consider, would you think a mound round the place would be preferable to having the building absolutely unenclosed?—I would rather have it enclosed so that the men in there should have equal pressure all round them. I would say, have the nearest approach to a cylindrical pit, down into which the men should go by ladders, because, directly you get an unequal pressure, you do not know what will happen; that has been proved just lately in my own experience, by the fact of two Chinamen, unfamiliar with compressed air bridge foundation works, being blown away and killed by an air charge of unequal pressure but comparatively moderate intensity.

999. In some explosions in the past, there have been some remarkable instances of the very much increased danger to houses in pits as compared with houses outside pits. Here are some photographs [showing same to the witness] illustrating the effects of an explosion which occurred at Hall's factory in 1879, in which there were $3\frac{1}{2}$ tons of powder exploded. *This* house was distant only 37 yards and surrounded by mounds, but open entirely from *that* side. Of course, the house is damaged, as you see, one end of it is almost cut out. *This* house is 67 yards off, but it is not nearly so much damaged as *this* house, which was situated more than double that distance, and which was in a pit absolutely surrounded by very high traverses; another house, 233 yards off, was injured very materially and that, too, was in a pit. The engine house, which was just outside the pit, escaped injury, even the windows of that engine house were not broken. Would not those facts go rather to show that having a pit round a house tended to increase the concussive or vacuum effects?—Yes, I think so; but I think also that would have been a perfectly harmless pressure with my ideal house, the damage would not have happened if the covering of the house had been weaker, and the sides enclosed with boards hung lightly on to hinges.

1000. I do not know whether the house you have in view could be constructed consistently with the other things required, do you think it could?—Yes, I think so. I remember seeing a signal box which had been caught in the Tay Bridge storm; it had never been properly finished, and the windows had been fastened in with only two or three brads; the suction outwards had left the signal box all right, because the window acted as a safety valve, the window being taken out; so that, I think the buildings would escape serious damage if the roof and side boards were very light and fastened by only a few brads, or something of that sort, and a board would not hurt a man if it did strike him in coming off.

1001. A traverse has two purposes, has it not, one being to break the effects of an explosion inside, and the other to protect the house inside from the effects of an explosion in another house?—Yes.

1002. As regards explosive effects, if you had the sea as at Ardeer, there would be no more harm in shooting out those effects in that direction than there would be in shooting them up, would there?—No.

1003. If you had a similar aspect of country here you would not, I presume, have any objection to *this* erection *qua* the effects in this exploded house?—I do not know that I should.

1004. If the atmospheric effects were the same, this house might be more harmless than if it were surrounded there?—I do not think that. I have a horror of unequal

pressure, but I do not mind anything if it is uniform. I have myself been under an equal pressure all round of as much as 5,600 lbs. a square foot, but of course you cannot stand that for more than an hour without getting paralysis. A man in a house in a pit with one of these waves going over it would be in much the same position as a miner going up and down the shaft of a deep mine, as regards variation of pressure, but directly you unbalance the pressure and divert the current laterally you render the man helpless.

1005. Suppose you put a traverse here, opposite the mouth of the other traverses?—If an explosion happened, sufficiently near, I think, the men would be blown or sucked out.

1006. But we have to consider the escape of the men even in an enclosed pit?—If an explosion happened inside, then it is all up with the men, but if it happened outside, then I would rather be in the pit, for the same reason that during a tornado, I would very much rather be "in the tornado cellar," as they say in America.

1007. *Sir F. Abel.* Then you would have the houses enclosed absolutely; no tunnels or any other openings?—That is what I should like.

1008. *Colonel Majendie.* They must have a tunnel if the material is to be taken down in a liquid state?—Yes, but possibly it might be closed by a strong timber portcullis. I would point out that the building on the reconstruction plan would not comply with my conditions; it is a very weak frame and a very strong skin, there is nothing to hold it down by, it would simply go up or be smashed down.

1009. That is what did happen to one of these buildings?—Yes, it went up and then came down.

1010. Was your attention called to the No. 1 gun-cotton store, where the building was smashed?—Yes, I remember a case happening in the Isle of Wight where, after a storm, the window curtains were found pinned under the roof; the roof had been sucked up and then let down again.

1011. Did you, at Waltham, see the buildings which had no traverses protecting them?—Yes.

1012. How have they been injured?—I fancy some of the more distant sheds had got caught in what we call the "sound wave" of plus and minus pressure.

1013. I suppose a screen, or earth mound, or wall, would have taken the "sound wave" over those houses?—Yes, I think it might if it had been of a certain height, but I do not think they were worth that, because the damage was so small.

1014. But it is serious as regards the disturbance of manufacture?—Yes.

1015. You noticed, I suppose, the houses which tower up, so to speak, behind the nitrating houses; they appear to have escaped in a remarkable way?—Yes.

1016. Do you attribute their escape to the air waves having been just diverted over them by the traverses?—When this exploded there would be an enormous vacuum formed just as in the centre of a tornado, and everything near would be swept towards that. I have no doubt the roofs of the near buildings and the thin skin of brickwork facing of the traverse would be damaged by the direct rush of air; you see much the same thing happens in sea works, where, if there is the least joint, the air is pressed during a storm into the joint and the stone is blown out; but I do not think a regular sound-wave action would have been set up so near the site of the explosion; it would be a sort of tornado blast.

1017. What was the direction of the wind, do you know?—I asked the question, and I think it was west to east, or thereabouts. Altogether it seemed to me a very reassuring thing that, considering the traverses were so weak, there should not have been worse local damage.

1018. Will the traverses, as shown in the reconstruction drawings, be superior?—Yes, they are well supported by banks of earth. Personally I should like to get rid of the tunnel access, or make provision for keeping it normally closed, because if there were another explosion in the neighbourhood, I think the men might get hurt.

1019. Was anything said with regard to the re-arrangement of these matters when you were at Waltham?—No, I offered no opinion upon them; in fact, I went down only to see the things and then think the matter over afterwards.

(*The witness withdrew.*)

Mr. James Milne Thomson, *re-examined.*

1020. *Sir F. Abel.* Referring to the evidence you previously gave to the Committee; I think you said the temperature to which you raised the soda solution before it came to the washing house was 70 degrees centigrade?—I think I said about 70 degrees centigrade when it enters the washing tank, but it is not above 50 degrees when the nitro-glycerine is mixed with it.

1021. First of all you run soda in at 70, and then the nitro-glycerine comes in and reduces it to 50?—Not exactly that; first of all we run soda in and then we put in nitro-glycerine, and then some more soda on the top. 50 degrees was counted as the maximum for the whole mixture, but 48 was the actual maximum.

1022. *Colonel Majendie.* No. 1 rule for the washing house says the temperature is not to exceed 50 degrees centigrade?—Yes, that is so.

1023. *Sir F. Abel.* But it must at sometime be higher, because you say you run cold in if it is too hot?—Of course it might momentarily be above 50 degrees if the soda solution was above 50 degrees in the washing tank, but a large number of trials showed that the soda solution was cooled to 50 degrees and under, by contact with the cold tank and the cooling action of the air stirring before the nitro-glycerine was run into it. The inflow of nitro-glycerine quickly cools the mass far below 50 degrees, and during the whole time the charge is being washed the temperature never rises above 48 degrees, as the man standing there with the thermometer regulates the supply of hot and cold water so as to get a general temperature of about 48.

1024. How long is it since you introduced the skimmer?—We have used it since the commencement.

1025. Had you any tap provided in the first instance to run the water off?—No.

1026. When the water is run off, what is the depth of the nitro-glycerine in the tank?—I could not say offhand, probably it would be about 18 to 24 inches. In the duplicate tank which we have just now, and which is fitted up exactly as the two were in that house, I poured in water up to the mark where the nitro-glycerine would come; I then pulled the skimmer up and let it fall, and it fell towards the centre of the tank; it did not strike the sides, and the indiarubber tube kept it from striking the bottom. I also tried it from a lower height and it acted in the same manner.

1027. *Colonel Majendie.* Suppose the skimmer were suspended inside the tank, what distance would there be from it to the sides?—If it were at the maximum height, it would be about the centre, but as it came down, it would move towards the side.

1028. Would the maximum distance be about a foot?—Not more than a foot.

1029. But when it was falling, would not the tube

tend to draw it further and further towards the side?—I think the tube would rather let it go.

1030. At any rate, may we take it that the skimmer, during your trials, did not preserve a perfect equidistance from both sides of the tank, according to the height at which it was?—That is so.

1031. But you do not think that, in any of these positions, it came into dangerous proximity to the sides?—No, it did not touch the sides at all.

1032. Have you ever seen it fall?—No, we have never had one fall.

1033. Have you seen it used at Ardeer?—Yes.

1034. *Sir F. Abel.* Were there air pipes in the drowning tanks?—Yes, they were both fitted with air pipes.

1035. Do you actually know how the washing of the nitro-glycerine that was let down into the drowning tank was carried out?—Yes, I washed it.

1036. Was it done by aëration?—Yes, we did it in a spare tank which we had in the after-separating house. We proceeded very much in the ordinary way, except that the soda solution used was not so warm.

1037. We gathered from the man Strange that he was not continuously working in the washing house, but that he was sometimes in the washing house and sometimes in the nitrating house, what was the object of changing men about?—That was the rule at Ardeer, and I carried it out in the same fashion.

1038. Do you think that a good system to follow?—Yes.

1039. Was that the arrangement when Mr. McRoberts was in charge at Ardeer?—Yes, they came down from the nitrating to the washing house.

1040. *Colonel Majendie.* You are a chemist, and we understand there were three other chemists employed on the works?—Yes.

1041. Were they all chemists of competence, were they educated chemists?—Yes, certified chemists; I am myself a Fellow of the Institute of Chemistry.

1042. Since we last saw you no doubt your mind has been a good deal occupied with this explosion?—Yes.

1043. Have you seen anything which will enable you to modify your former statement that you were unable to suggest the cause of the accident?—I am as far away as ever. I began by thinking of the skimmer, and for the purpose of testing the question, I tried the experiments I have already mentioned, but I am no nearer a conclusion than I was before.

1044. Was there any other way outside the conditions included in your experiments in which the skimmer could have come into violent contact with the apparatus?—No.

1045. Was any part of the skimmer recovered?—No, I have not seen any of it.

1046. Were you present when Mr. Guttmann was at the works the other day?—No.

1047. Have you looked at all at the leaden gutter that led from the washing house to the other house?—Yes.

1048. Does it suggest to your mind that the explosion proceeded by that route?—No, the gutter remains quite whole, it is only flattened by the falling of the tunnel.

1049. Is there any fusion?—No, none whatever.

1050. Was the gutter blown away at all?—No, it is lying there still.

1051. In the ordinary process of manufacture, was there any permanent deposit, so to speak, of nitro-glycerine in the gutter, or did the material run freely; we understand the gutter was V-shaped; was there any accumulation at the bottom of the V?—Not in warm weather, but in cold weather the nitro-glycerine used to freeze.

1052. But it would not freeze in such weather as we had at the time of the explosion?—No.

1053. *Sir F. Abel.* Do you think there would be any chance of a lodgment of nitro-glycerine here and there?—No.

1054. Did the lead become at all corrugated at any time?—No, because there was no special heat applied to that gutter; it was one of the best gutters in the factory.

1055. *Colonel Majendie.* Was it not supported by pieces of wood at intervals?—Yes.

1056. Were there any depressions between the supports?—There might be, but only little ones.

1057. But there would never be anything in the nature of a continuous stream of nitro-glycerine in the trough, I suppose?—No.

1058. *Sir F. Abel.* After a day's work water was run down, was it not?—Yes.

1059. *Colonel Majendie.* Have you considered the question of absorbing the nitro-glycerine in nitro-cotton directly after it is purified, instead of accumulating it?—Yes; there was only one occasion on which we were troubled with exudation in the cordite, and on taking a sample of the guncotton we found that the moisture was correct but the nitro-glycerine contained rather more water than usual

1060. *Sir F. Abel.* What was the amount of water?—1 per cent.

1061. Dry guncotton contains about 2 per cent.?—Yes. I found afterwards that guncotton was variable in its moisture, and now I think it was due to the guncotton and not to the nitro-glycerine.

1062. Have you ever made any observations with regard to the temperature of the nitro-glycerine when transferred to the store tank?—No.

1063. At what temperature would it leave the washing tank?—At about 40 degrees.

1064. Therefore it would have to cool down, otherwise it would come down warm on to the guncotton?—Yes; but it is a very long gutter, and that would bring it down to about 20, perhaps.

1065. *Colonel Majendie.* Do you think the amount of water you mention would matter in regard to cordite?—No.

1066. Do you see any possible objection to carrying out the absorption by premixing the stuff?—No.

1067. Do you see some advantages in it?—Yes.

1068. You would do each batch at a time, would you not?—Yes.

1069. That would be a great advantage?—Yes, that would be very much better. Here are some notes with reference to the various temperatures at which nitro-glycerine is washed in some foreign manufactories. Shall I read them?

1070. *The Chairman.* If you please?—"Krummel uses soda solution, 50 to 55 degrees centigrade; nitro-glycerine gradually rises to and is kept at above temperature by adding water of the necessary warmth. Nitro-glycerine is allowed to cool down to 30 before pouring off. Schlebusch uses soda solution 60 degrees, whereby nitro-glycerine is raised to 54; after washing, temperature of nitro-glycerine is 48, and is cooled down to 25 before pouring off. Pressburg washes cold."

(*The witness withdrew.*)

APPENDICES.

SUBJECT.

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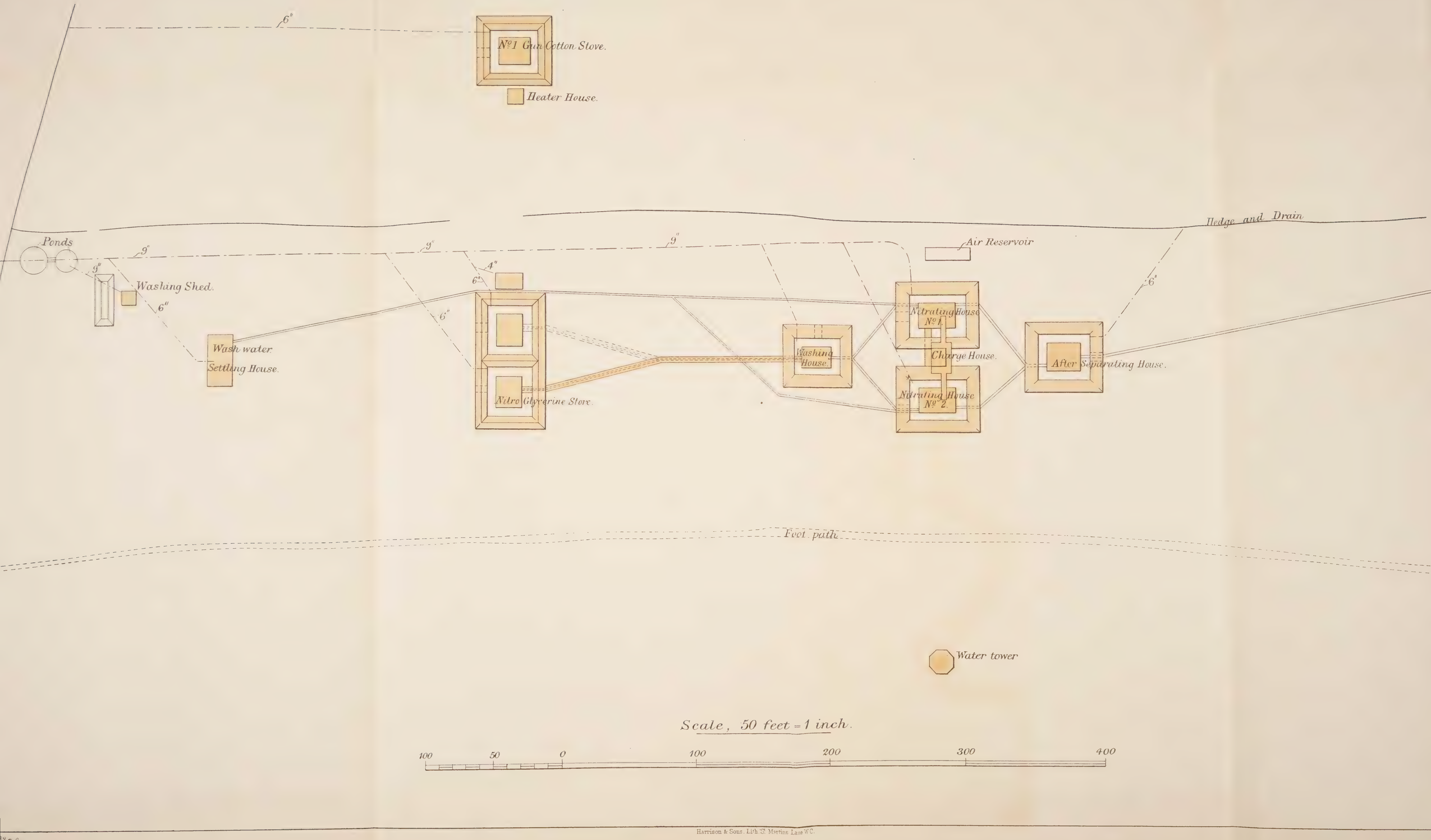
PLAN OF THE CORDITE FACTORY AT WALTHAM ABBEY, COMPRISING THE NITRO-GLYCERINE AND GUN COTTON FACTORIES.

— Scale $\frac{1}{2500}$ or 25·344" to a Statute Mile. —

(750.8/94.1229)239 W.O.

Harrison & Sons Lith. St. Martins Lane W.C.

PLAN OF NITRO-GLYCERINE FACTORY.



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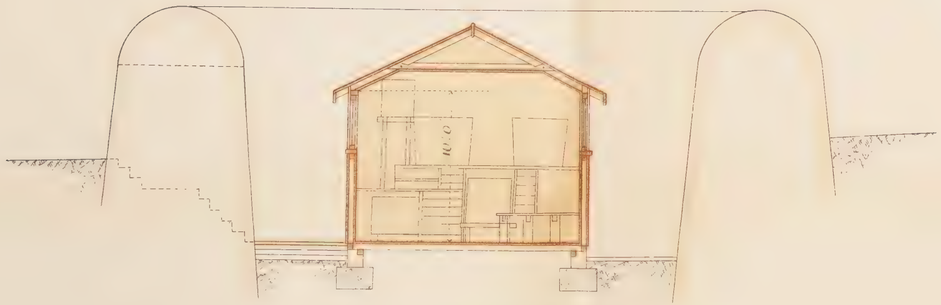
WALTHAM ABBEY

PLAN OF NITRO-GLYCERINE FACTORY.

WASHING HOUSE.



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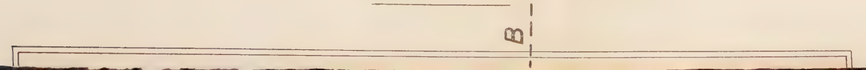

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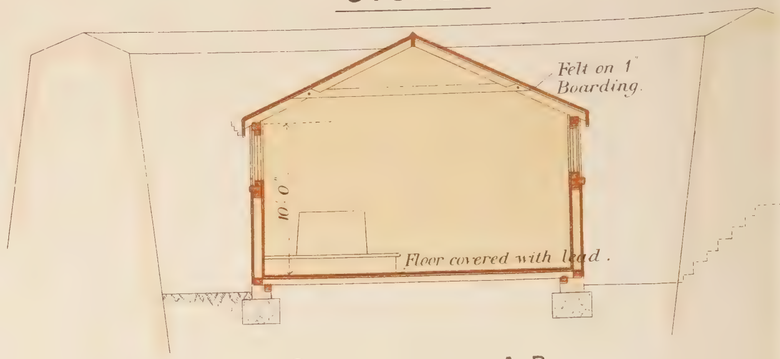

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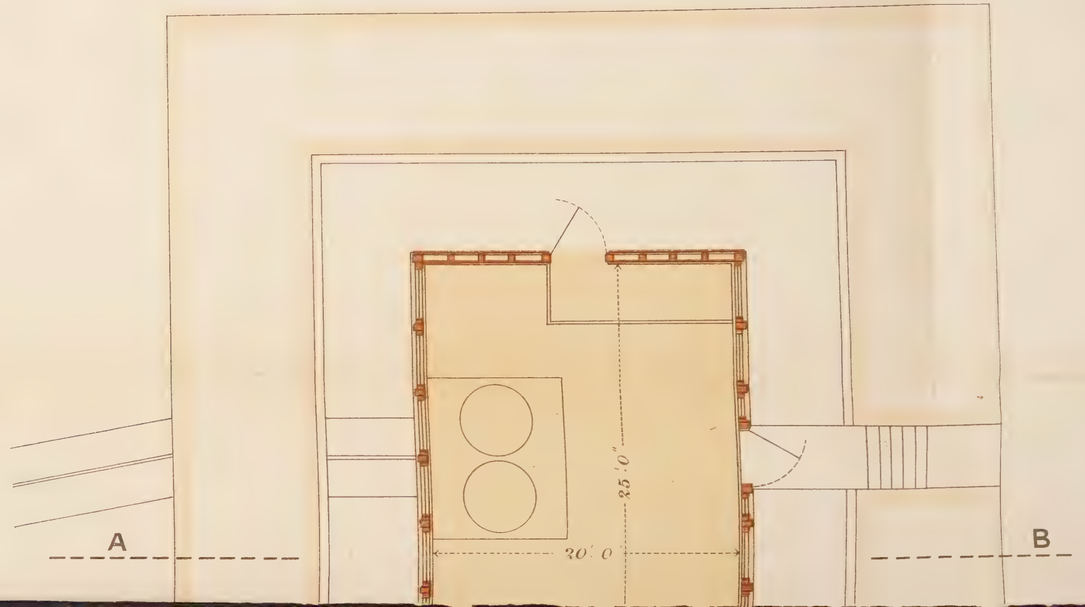

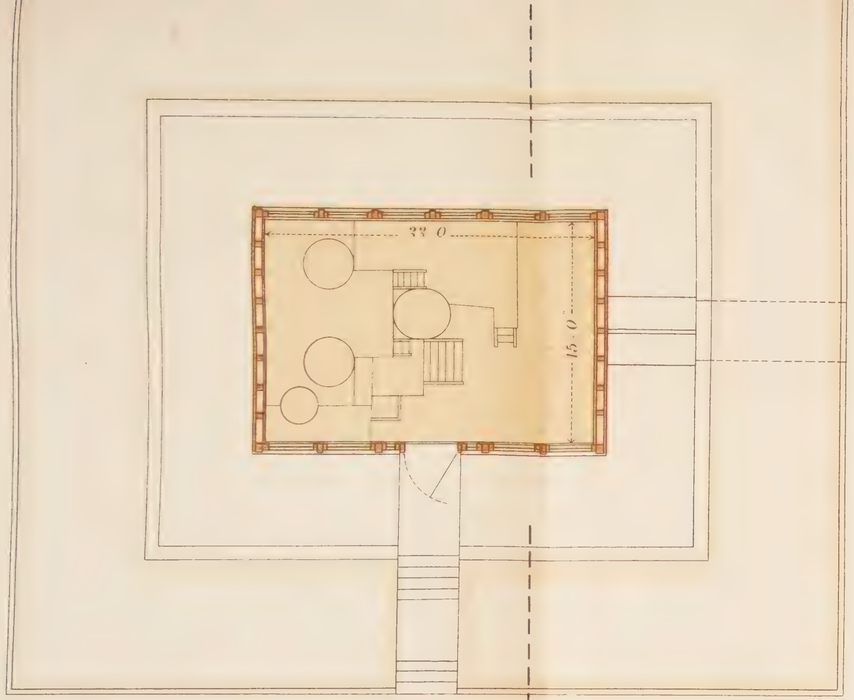

A

PLAN.

Scale 8 Feet = 1 Inch.

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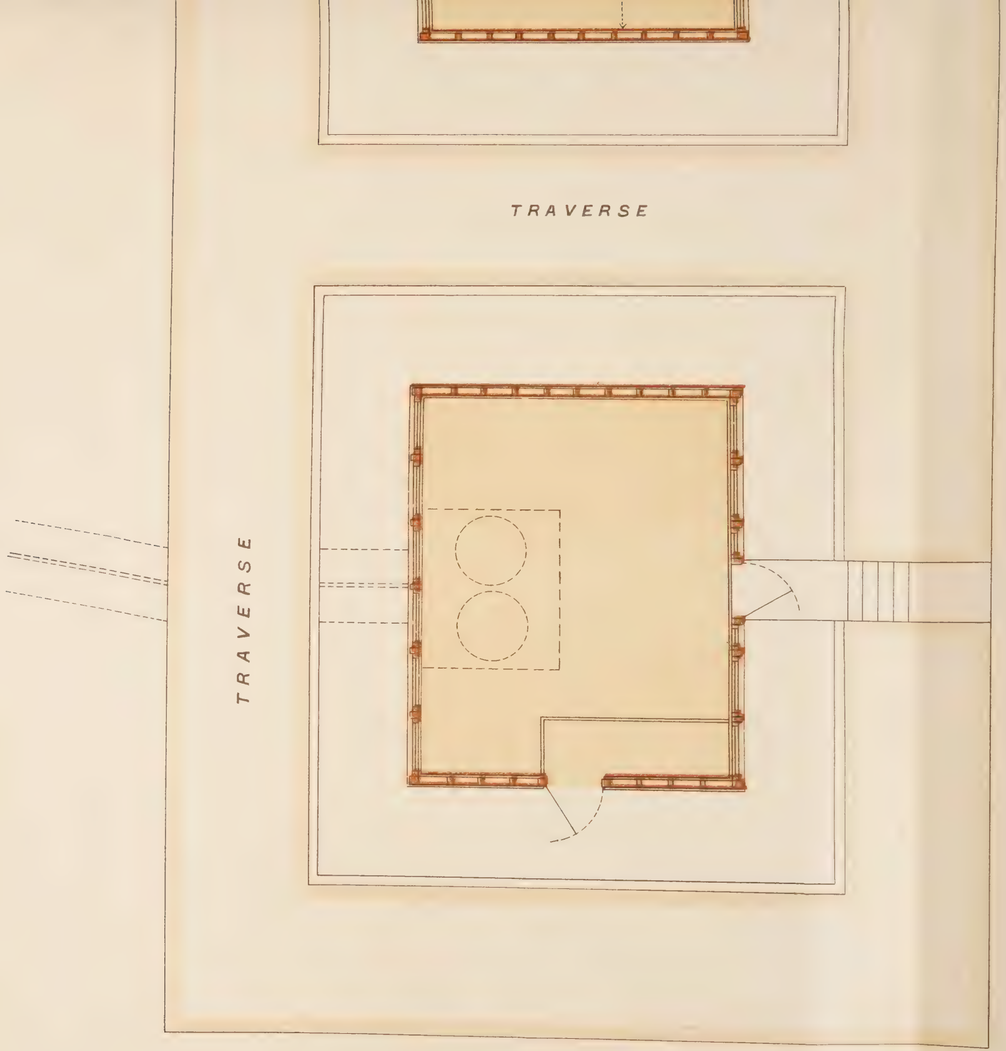

PLAN.

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APPENDIX IV.

Rules and Regulations for Nitro-Glycerine Branch.

Manager and Principal Chemist.

1. The manager will have general charge of the branch, and be responsible that all the regulations connected with the manufacture are strictly carried out.

Assistant Chemist.

1. The Assistant Chemist will assist the manager in the general oversight of the branch.

2. In the absence of the manager, the Assistant Chemist will have general charge of the branch, and be responsible that all the regulations connected with the manufacture are strictly carried out.

Foreman.

1. Before the acid is run into the nitrating apparatus, the foreman or other person who superintends this operation must satisfy himself by personal examination—

(1.) That the high-level tanks are full of water.

(2.) That the drowning tank in the nitrating house is nearly full of water.

(3.) That the wash-water settling tank is nearly full of water.

(4.) That the nitrating apparatus is free from water.

N.B.—A little may have collected from the last night's washing of the coils, but it should not exceed a tumbler full or so.

(5.) That the air-cocks, stoneware cocks, and air-gauges are in good order.

(6.) He is to open the water trap of the air-pipes and blow off the condensed water.

2. When he has ascertained that all is right, he should open the water taps of the coils and let the water flow through them, at the same time he should let-off air that may have accumulated in the pipes.

3. It is the duty of the foreman to examine carefully every day the whole of the apparatus and plant under his charge.
The examination is to be as thorough as possible, so that he may feel confident that everything is in order.

4. The foreman shall accompany the plumber on his weekly inspection of the plant, and point out all known defects.

5. The foreman should take pleasure in having his whole department in the finest order at all times, and in the best possible condition for carrying on the work.

6. The foreman must not leave the department for meals or other business until relieved.

Nitrating Houses.

1. Before the mixed acids are run into the nitrating apparatus, the connection with the drowning tank must be placed in position, and ready at a moment's notice.

2. The mixed acids are to be cooled down by means of the coils, and by air stirring until the temperature fall to 16° C., before glycerine is allowed to enter the apparatus. When the temperature has fallen to 16° C. the injector may be opened. If the acids are below 16° C. the injector may be opened at once.

3. The person in charge of the operation must watch the thermometer, and if it should rise too quickly the inflow of glycerine must be checked, and on no account is the

temperature to be allowed to exceed 22° C. If the temperature should rise beyond 22° C., the injector is to be closed and additional air let on through the auxiliary air-pipe, and no further inflow of glycerine is to be allowed until the temperature has fallen below 22° C. The glass fume tube is to be watched, and if red fumes should appear, the injector must be immediately closed, and additional air let on until red fumes cease. If they continue and cannot be stopped, then the whole charge is to be run into the drowning tank, the air being kept on both tanks all the time.

4. When the whole of the glycerine has been injected into the apparatus, and the temperature in it has fallen to 16° C., the whole of the contents are to be discharged into the separating tank by turning the tap leading thereto. Before running the charge into this tank, it must be seen that the connection with the drowning tank is in position, that there is no water lying in it, and that the taps are closed.

5. From the moment the charge arrives in the separating tank, until it is run down to the washing-house tank, it must be watched closely. In the separating tank the temperature must not be allowed to exceed 17° C.

6. If the nitro-glycerine in the separating tank should show signs of heat, or should give off red fumes, the air must be turned on at once, and if the heat cannot be kept down to 17° C. and red fumes are given off, then the charge must be sent to the drowning tank. The air must be kept on both tanks during the running off.

7. When the nitro-glycerine is sufficiently separated from the acid, the tap leading to the after nitrating house is to be opened, and the contents allowed to flow through the gutter into the refuse-acid tank until the nitro-glycerine has reached the gauge glass, when the tap is to be shut. The tap leading to the pre-washing tank is then to be opened and the nitro-glycerine run slowly into the tank.

8. As a rule, the temperature in the pre-washing tank is not to exceed 18° C., and it is better to keep it lower, if possible. This, except in very hot weather, can be managed by copious washings with water.

9. All the washings are to be run to the wash-water settling tank.

10. When the nitro-glycerine has been well washed with water it is to be run to the final washing tank in the washing house, into which a quantity of soda solution at a temperature of about 70° C. has previously been run.

Washing House.

1. The nitro-glycerine must be thoroughly washed in the washing tank until every trace of acid be removed. The temperature in this tank must not exceed 50° C.

2. Every charge of nitro-glycerine washed in the washing house must be carefully tested by the Chemist, to ascertain its freedom from acidity, before he allows it to be run into the filtering tank.

If the Chemist finds it unsatisfactory, he must continue the washing as long as he thinks necessary, and until a fresh sample shows the charge to be free from acidity.

3. After filtering, the charge is to be run to one of the store tanks in mixing house No. 2.

4. All the washings are to be run to the wash-water settling tank.

Mixing House No. 2.

1. The weigh bridge is to be frequently tried, in order to ensure accuracy in weighing.

2. All the washings are to be run to the pond.

3. The temperature of the house is to be taken and noted in a book before beginning to weigh out nitro-glycerine, and work must not be commenced if the thermometer has registered below 50° fahr. since the previous weighing, until the manager has been duly informed, and the necessary precautions and arrangements have been carried out.

Wash-water Settling House.

1. The nitro-glycerine which gathers in the tank is to be drawn off in buckets.

If clean, the nitro-glycerine may be washed in the washing-house tank, but if muddy, it must first be washed and filtered in the washing shed, and finally washed in the washing-house tank.

2. All the wash-water is to be run to the pond.

3. The gravity of the liquid in the wash-water tank must not exceed 6° or 8° Twaddell, otherwise the lining will be rapidly destroyed. Fresh water must be run into the tank every time it is used for drowning acid, unless the quantity of acid is very small.

Pond.

1. The pond is to be fired every month, and all the workpeople must be clear of the department at the time.

After Nitrating House.

1. When a charge of refuse acid arrives in the tank it is to be run as soon as possible to one of the separators, and the tank and pipes washed with settled acid.

2. The acid in the separators is to be allowed to remain there one or more days, to give the nitro-glycerine time to separate from the acid. The nitro-glycerine which appears on the surface is to be drawn off from time to time, and drowned in the small tank provided for that purpose inside the house.

3. The temperature of the nitro-glycerine in the separator is to be taken from time to time, and if it rises above 20° C., air is to be turned on occasionally. If the temperature cannot be kept under 25° C., the contents of the separator is to drowned in the after nitrating drowning tank, air being kept on both during the operation. After settling for one or more days, the acid is to be run to the tank at the refuse acid shed.

4. If red fumes are given off the acid in any separators at any time, air should be turned on. If they still continue and the temperature is rising, the contents of the separator should be drowned in the drowning tank, air being kept on both during the operation.

5. All the washings are to be run to the drowning tank.

General.

1. In winter, when nitro-glycerine is frozen and taps are frozen, it is necessary to be most careful in handling them. They are to be thawed with cloths soaked in warm water, or by the direct application of moderately warm water. The thawing is to be continued till the keys turn without difficulty, and with the usual pressure.

2. Drops of nitro-glycerine which may splash over any of the tanks should be wiped up at once with a cloth. In the wash-water settling house spilt nitro-glycerine may be washed down the drain with a hose.

3. The whole of the houses, as well as the apparatus of all kinds, are to be kept in thorough order and perfectly clean. No rubbish of any kind is to be allowed in or near any of the houses, and nothing is to be kept inside which is not required for the immediate use of the house.

4. As a rule, no work is done on Saturdays, except that of cleaning and repairing. On that day all tanks, gutters, and pipes are to be thoroughly cleaned before the plumber commences his weekly inspection. Any defects in air pipes, acid pipes, gutters, tanks, cocks, water pipes, steam pipes, &c., must be thoroughly repaired, and everything put in good order.

5. In every case it is the duty of the foreman plumber, when defects are brought to his notice, or discovered by himself, to have them made good before the making of nitro-glycerine is resumed.

6. Before the plumber goes his round of inspection, the apparatus of all kinds must be thoroughly cleaned and free from nitro-glycerine.

7. Every operation in the department is to be done as part of a system, regularly and unfailingly. The men must learn the work so thoroughly that they cannot commit blunders. No changes in the routine of the work are allowed. Every duty is to be performed in the prescribed way, and no deviation will be permitted.

W. H. NOBLE, *Major-General,*
Superintendent, Royal Gunpowder Factory.

February, 1892.

APPENDIX V.

RETURN showing the names, duties, qualifications, and salaries of the chemists employed in the Cordite Factory, Waltham Abbey, at the time of the accident of 7th May, 1894.

Name of Chemist.	Duties.	Technical qualification.	Salary per annum.
			£ s.
James Miln Thomson.	Manager of cordite factories, which include nitro-glycerine factory.	Fellow of the Institute of Chemistry. Studied and practised chemistry at the City Analyst's Laboratory of Glasgow for 5½ years. Acted as chemist to Port Dundas Alkali Company, Glasgow, for 1 year. Engaged at Nobel's Explosives Company's Works at Ardeer for 9 years, during which time he occupied the following positions at different times :— Superintendent of Chemical Laboratory. Superintended manufacture of nitro-glycerine and dynamite. Superintended manufacture of nitro-cotton and of blasting gelatine. Manager of cordite factories for 4 years	480 0
William Thomas Thomson.	Chemist in charge of guncotton factory. In charge of cordite factories during absence of manager.	Studied and practised chemistry for 2 years in the College of Science and Art, Glasgow, and acted as Assistant Chemist in the City of Glasgow Analyst's Laboratory for 5 years. Acted as chemist in the cordite factories for 3½ years, being specially instructed in the properties and manufacture of nitro-glycerine during that period.	195 0
William Bennie ..	Chemist in charge of nitro-glycerine factory.	Studied and practised chemistry for 2 years in the College of Science and Art, Glasgow, and acted as Assistant Chemist in the City of Glasgow Analyst's Laboratory for 3 years. Acted as chemist in the cordite factories for 2 years 8 months, being specially instructed in the properties and manufacture of nitro-glycerine during that period.	124 16
Robert Robertson	Chemist in charge of chemical laboratory. Also in charge of nitro-glycerine or guncotton factories during absence of chemists attached to these factories.	M.A., B.Sc. of St. Andrew's University. For 2 years in Chemical Laboratory under Professor Purdie. Acted as Assistant Chemist in the City of Glasgow Analyst's Laboratory for 2 years. Acted as chemist in the cordite factories for 2 years 3 months, being specially instructed in the properties and manufacture of nitro-glycerine.	124 16

APPENDIX VI.

STATEMENTS showing particulars of the damage caused by the explosion of 7th May, 1894.

A.

Question.	Reply.
	yards.
(1.) Radius within which serious structural damage was effected (such as destruction of substantial walls and masonry buildings).	95
(2.) Radius within which minor structural damage was effected (such as injury to unsubstantial buildings and structures, breaking of window sashes, doors, &c.).	900
(3.) Distance to which heavy *débris* was projected	700
(4.) Distance to which lighter *débris* was projected or carried—	
Distinguishing between—	
(1.) The direction of the wind	650
and—	
(2.) The opposite direction	120
(5.) Distances at which windows were broken	"Robin Hood" Public House, Epping Forest—glass broken and plaster shaken; distance, 2 miles 3½ furlongs, S.E. direction. Glass broken at High Beech, about 2 miles S.E. direction. Pickhill Farm—glass and plaster, 1¾ miles, direction E.N.E. Glass broken at Waltham New Town, Waltham Cross, about 1⅛ miles, direction N.W.

B.

List of damages to buildings.

Building.	Distance from washing house.*	Distance from nitro-glycerine store.*	Nature of damage.
	yds.	yds.	
Stables and stores ..	273	345	Tiles moved, and blown off. Boarding broken.
Farmhouse	276	348	Walls cracked, ceiling cracked, chimney-pot off; windows cracked and broken.
Acid separating house .	285	357	Frame of door shifted.
Guncotton Factory.			
Acid store	297	367	Hooks in roof displaced, and windows broken.
Boiling house	319	385	Glass and frame of skylight broken.
Guncotton office ..	356	416	Fanlight broken.
Tinman's shop ..	380	440	A few slates broken and porch slightly sprung.
Guncotton magazine ..	405	462	Windows broken on east side.
Cottonwaste store ..	253	322	Roof strained and templates shifted; windows broken.
Shifting-room	225	298	Slates and windows broken.
Dining-room	222	293	Roof strained, window sashes and glass broken.
Main building, Guncotton Factory.	275	343	Roof broken in in places, slates moved, catches and locks of doors strained; window sashes and glass broken.
Big room	307	370	Frames and glass in windows and skylights broken.
Press house, No. 3 ..	357	415	Ceiling down; no windows broken.
Air-compressor house .	285	345	Bolt off door.
Plumbers' office ..	350	406	Windows broken.
Nitro-glycerine Factory.			
Nitrating house, No. 1	37	109	Traverse split and broken up on south side, house shattered badly.
Nitrating house, No. 2	37	108	House shattered severely.
Charge house	40	111	Shattered severely.
Washing house ..	..	61	Traverses levelled and blown with house in all directions; a large quantity in south-east direction.
Nitro-glycerine store..	61	..	Similar to washing house, iron gate and plates found 400 yards south of store.
After separating house	83	156	Roof lifted; window sashes and glass broken.

* These distances are as measured from the outside of the buildings.

Building.	Distance from washing house.*	Distance from nitro-glycerine store.*	Nature of damage.
	yds.	yds.	
Mixing house, old ..	61	10	House buried by east, and parts of north and south traverse crushed in.
Wash-water settling house.	138	70	Building badly shattered; all glass broken.
Washing-shed ..	154	88	No damage.
Water tower	82	128	Doors blown in, window frames and glass broken.
Cordite Factory.			
Engine house, No. 1 guncotton stove.	62	24	Brickwork and woodwork shattered badly.
Gas-engine house, No. 1 guncotton stove.	62	24	Brickwork and woodwork shattered badly.
Guncotton stove, No. 1	98	85	Roof forced in and sides bulged out and shattered.
Guncotton weighing room.	98	56	Brickwork cracked. Roof and porch shattered badly.
Guncotton store ..	135	110	Roof lifted, match-lining broken and down (inside). Fanlight over door blown out. Glass broken in skylights.
Reel stove	205	184	Roof split and shifted, slates broken.
Acetone stores, 1, 2, and 3. ..	172	169	Iron roof supports bent, corrugated iron torn off; window sashes drawn out and broken.
	227	224	
	286	282	
Tray stove, No. 3 ..	290	258	Brick blown through door (porch) and match-lining shifted; glass broken.
Tray stove, No. 1 ..	276	234	Framing of porch sprung; glass broken in window.
Dining and shifting rooms.	334	293	Ceilings down in places; skylights and sashes of windows broken.
Press house, No. 1 ..	200	150	Engine house shattered, frames of skylight and windows broken. Two holes in roof (falling pieces of cement); slates broken and off.
Press house, No. 2 ..	153	100	Roof sprung, stone coping broken on roof; doors blown in at west end; frames of windows and skylights broken; glass out.
Reeling house.. ..	127	63	Brickwork cracked; roof shattered; doors off; west end frames of skylights broken; all glass out.
Incorporating houses, Nos. 1 and 2.	188	119	Doors and roofs slightly sprung; slates broken; holes in roof. Frames of windows and skylights broken; all glass out.
	164	95	
Incorporating houses Nos. 4 and 3.	185	125	Roofs damaged and shifted; slates broken. Frames of skylights broken, and all glass out. Doors sprung; glass covers of four machines broken, and glass in charges of cordite.
	207	143	

* These distances are as measured from the outside of the buildings.

Building.	Distance from washing house.*	Distance from nitro-glycerine store.*	Nature of damage.
	yds.	yds.	
Blank cutting house ..	184	115	Framing of building shifted; glass broken in windows and skylights; doors sprung.
Mixing house (new) ..	174	105	Framing and match lining damaged; doors sprung; window sashes and glass broken.
Solvent and general store.	188	150	Roof slightly sprung; doors sprung; window sashes and glass broken.
Tray stove, No. 2 ..	208	179	Door sprung; sash blown out at west end; gauze in window drawn out; glass broken.
Blending house ..	235	236	Window sashes and glass of east side blown in; glass in windows round house broken opposite electric lamps.
Box house	288	284	Roof supports bent; window sashes and glass drawn out on east side and broken; doors sprung.
Red magazine.. ..	177	217	Porch damaged and glass broken; doors sprung.
Instrument room, proof range.	374	417	Glass broken.

* These distances are as measured from the outside of the buildings.

APPENDIX VII.

STATEMENT showing the duties of the Superintendent, Royal Gunpowder Factory, Waltham Abbey, handed to the Committee by Colonel W. McClintock, Superintendent. (*See* Question 624.)

1. The Superintendent is immediately and alone responsible to the Director-General of Ordnance Factories for the whole internal management of the factory under his direction, both in regard to efficiency and economy.

2. All persons employed in the factory are immediately responsible to the Superintendent for the proper performance of their respective duties, and are in no way independent of the Superintendent.

3. All correspondence with the War Office and other departments of State must pass through the Central Office, and minutes must not be written on War Office papers except under special instructions from the Director-General of Ordnance Factories.

4. Correspondence with contractors, except in the case of small purchases, involving any change in the rate or nature of supply must also pass through the Central Office.

5. The Officer attached to the department, as in charge of danger buildings, is to be considered as an Assistant to the Superintendent, and therefore at his disposal for supervising manufacture, proof, and departmental experiments.

6. The Civil Staff Officer attached to the factory will be responsible to the Superintendent that the clerical duties, the accounts, and financial matters generally are carried out in accordance with Service customs and regulations, and he will be responsible to the Superintendent for the custody of all stores, and countersign all certificates for cash payments.

7. Communications on technical and other subjects from the factories should be considered as submitting the views of the Superintendent of the factory, based on information derived in the department. It will not be necessary, unless under exceptional circumstances, to attach the memoranda or suggestions of subordinates.

8. No expenditure of any kind on plant, except ordinary repairs chargeable to Indirect Expenditure, is to be incurred without previous sanction of the Director-General of Ordnance Factories.

9. The estate is to be in the care of the Superintendent, Building Works, who will have charge of the crops and plantations; he will plant and fell trees and prepare the timber for stacking; he will also gather in the hay or other crops, and sell the same for the benefit of the factory.

10. No game of any kind is to be reared on the lands, nor any live stock or poultry kept for the benefit of any one serving in the factory. Ground game will be kept down by the Building Works, but no shooting will be permitted.

11. The fishing regulations will be as at present.

12. No one unconnected with the working of the factory will be allowed to navigate the waters near the danger buildings, as will be indicated, either for business or pleasure, nor will the families of those connected with the factory be permitted on these waters during the time the factory is at work, and at other times only by special permission of the Superintendent, and at their own risk.

13. No works, other than repairs connected with the machinery inside the buildings, overhead steam and air pipes, are to be undertaken by the factory. Repairs to buildings, new buildings, underground pipes, and all kinds of earthwork, road making, &c., is to be undertaken by the Building Works on requisition.

14. The care of electric light leads, engines, and dynamos, and the repair and maintenance of same, are to be considered as Building Works service, but the machinery will be worked by the factory.

15. The maintenance of tramways and rolling stock will be undertaken by the Building Works as far as supply and renewal are concerned; they will, however, be worked by the factory.

16. The maintenance of the gas works, gas pipes, and every kind of fitting will also be considered as Building Works service, but the gas making will be done by the factory.

17. The duties of the water warders will be confined to regulating the water in the canals; the custody of the estate will be in the hands of the police.

APPENDIX VIII.

COPIES of correspondence handed in by Colonel W. McClintock (*see* Question 624), relating to certain disciplinary matters connected with the Royal Gunpowder Factory, and to the transfer of the management of the Waltham Estate to the Building Works Department.

A.

Police report as to drunken workman, employed in the Royal Engineer Department, endeavouring to enter Royal Gunpowder Factory.

Police Station, W[illegible] partment,
th December, 1892.

Police constable 316 H O'Donnell reports that at 1.10 p.m., 19th instant, Harry Dean, a labourer employed in the Royal Engineer Department, Quinton Hill, left the works at 12 noon by Quinton Hill Gate, all correct for dinner, but upon his return at 1.10 p.m. the police constable discovered him to be drunk, and his re-admittance to the works was disallowed by the police constable, and Dean then went quietly away.

A. PUNT, *Serjeant*,
For Chief Inspector.

Waltham Abbey,
Assistant Superintendent, Building Works, 19th December, 1892.
The annexed report is forwarded for your information.

W. McCLINTOCK, *Lt.-Col., R.A.*,
Superintendent.

Superintendent, Royal Gunpowder Factory, 20th December, 1892.
Report returned herewith. The man has been admonished.

H. H. MUIRHEAD, *Major, R.E.*

Chief Inspector of Police, 21st December, 1892.
To see.

W. McCLINTOCK, *Lt.-Col., R.A.*,
Superintendent.

21st December, 1892.

Seen.

H. CRAGGS,
Chief Inspector.

B.

Master of barge refused admission to Factory.

Police Station, Royal Gunpowder Factory,
Superintendent, Royal Gunpowder Factory, 25th October, 1892.

I beg to report that at 9.50 p.m., 24th instant, Charles Pryor, Master of barge "John of Rochester," owner, R. Jones, contractor, Maidstone, Kent, lying in the Government waters at the Old Quarters, demanded admission to go on board for the night, but Serjeant No. 40 N. Smith considered him under the influence of drink and refused to admit him, and he went away quietly.

Pryor had previously been seen by Water Warder D. Ward attempting to get over the fence into the Government quarters, and as he was drunk handed him over to the town police, who saw the Colonel Superintendent, and acquainted him with the facts, in consequence of which Pryor was released, and subsequently made his demand to go on board the barge, as stated above, and was refused.

H. CRAGGS,
Chief Inspector.

Assistant Superintendent, Building Works, 25th October.
Please see annexed police report.

W. McCLINTOCK, *Lt.-Col., R.A.*,
Superintendent.

Superintendent, Royal Gunpowder Factory, 26th October, 1892.
Noted. This barge and Charles Pryor have since sailed away.

H. H. MUIRHEAD, *Major, R.E.*

C.

Question of Estate being taken over by Building Works Department.

Director-General of Ordnance Factories, 20th October, 1892.

Major Muirhead has been directed to take over the estate gang at Waltham Abbey, in accordance with the instructions received by me, but on communication with the Superintendent, Royal Gunpowder Factory, has been informed that definite instructions from you had not been received, and that until such instructions were received the matter was in abeyance. Perhaps, therefore, you would cause instructions to be sent. I understand your wishes to be that the whole of the estate work, including that of timber, grass, roads, fencing, &c., should in future not be done by the factory, but by the Building Works Department.

In deference, however, to the Superintendent, I propose, if you see no objection, to detail a couple of men from the gang, who will remain on Building Works Department pay, but who will be placed under the orders of the Superintendent for trimming grass, clearing walks, &c.

M. T. SALE, *Colonel.*

Superintendent, Waltham, 25th October, 1892.

Please see 106,383. Are not the instructions therein sufficient, please?

W. ANDERSON,
Director-General of Ordnance Factories.

Director-General of Ordnance Factories, 27th October, 1892.

I certainly understood you to say, when you were here with the Accounts Committee, that the question of handing over the estate to the Building Works Department was to stand over until you had further considered it.

I pointed out to you on that occasion that this factory, owing to the nature of its manufacture, was in quite a different position to the other ordnance factories, and that it would be a serious source of danger if there were a number of men employed here over whom I had no control. As an example of this see annexed correspondence with Assistant Superintendent, Building Works. Drunken men are a nuisance in a powder factory, whether by day or night, and if under my control, this man should never enter the factory again.

I shall be very glad if you can modify the instructions sent with 106,383, so far as to leave the cutting of wood (which is a part of manufacture) and the care of walks in my hands. The Building Works Department could still save and sell the hay crop, and I could hand the waste wood over to that department for sale.

At present men employed in the factory are allowed to buy waste wood, see War Office papers, 61/Gunpowder Factory/775.

Is this indulgence to be continued?

W. McCLINTOCK, *Lt.-Col., R.A.*,
Superintendent.

Superintendent, Building Works, 12th October, 1892.

To see.

G. M. S.,
For Director-General of Ordnance Factories.

Director-General of Ordnance Factories, 17th November, 1892.

It would be well, I think, if the questions raised were definitely settled, if as it appears some fuller instructions supplementary to those given on 106,383 are desired. The arrangement, as I take it, is that all estate work whatever is done by me, including the stacking of timber. The stacks then formed would be handed over to Royal Gunpowder Factory as required; they would take from them all the wood they wanted, and all residual wood to be collected and from time to time sold by auction or by tender.

I certainly think that the custom of allowing employés to buy wood should be stopped, if the War Office paper 61/Royal Gunpowder Factory/775 covered it, which does not seem to me to be the case. I do not quite understand how the vagaries of a drunken bargee affect the question.

Contractors' barges, manned by civilians, must from time to time have access to the factory, and such misconduct will recur.

M. T. SALE, *Colonel.*

Superintendent, Waltham Abbey, 19th November, 1892.

I am sorry that there has been a misunderstanding in this matter. It has been settled that the estate at Waltham Abbey should be treated in the same manner as any other War Office property, and I cannot see any valid reason for making any exception. The nature of the manufacture does not differ in point of danger from that carried on in the Royal Laboratory danger buildings, and no inconvenience is there experienced from the land being under the control of Building Works. The case you cite does not appear to bear on the question, and you would be quite within your right to refuse to admit the man again.

You have the advantage of a resident Royal Engineer, and I feel sure that the work of the place will go on smoothly and safely with a little tact. I do not think that any sales should be made to employés in the factory.

W. ANDERSON,
Director-General of Ordnance Factories.

Director-General of Ordnance Factories, 25th October, 1892.

The estate was handed over to the Assistant Superintendent, Building Works, on the 11th instant. I note that no sale of coke or wood is to be made to employés of the factory in future.

W. McCLINTOCK, *Lt.-Col., R.A.*,
Superintendent.

APPENDIX IX.

MEMORANDUM addressed by Colonel M. T. Sale, R.E., to the Director-General of Ordnance Factories, with reference to his evidence of the 18th May.

Director-General of Ordnance Factories,

Referring to the proposed change in shape of the traverses of the reconstructed nitro-glycerine store and wash-house, Quintin Hill, I understand, from what you told me on Saturday, that it is in contemplation to make these traverses U-shaped, instead of circular in plan.

Before such a change is made, I should like to bring to notice one or two points which, I think, deserve consideration.

Whatever opinion be held as to the degree of protection afforded by circular traverses to the building within them, there can hardly be a doubt that circular traverses held up by a circular revetment placed as close as possible to the building they enclose, confine the effects of an explosion taking place inside within the narrowest possible limits, and minimize the lateral effects.

In this respect, traverses circular in plan must obviously be much superior to traverses U-shaped in plan.

But in the two buildings now being reconstructed, it is peculiarly necessary that every possible means should be taken to confine the effects of an explosion in either building, and to minimize lateral effects, seeing that these buildings are destined to contain considerable quantities of the most powerful, and by far the most dangerous, explosive used at Quinton Hill, and are, to a great extent, surrounded by other danger buildings.

Unless, therefore, it can be shown by clear and positive evidence that U-shaped traverses protect their enclosed buildings much better than circular traverses; it would seem wrong to abandon the latter, and to use a form of traverse which is certainly inferior, as regards its power of confining the effects of an explosion.

As the wave of concussion following an explosion must, apparently, be—like a sound wave on an enormous scale—not so much a rush of air as a wave of compression and exhaustion, it is by no means clear that the break in the line of traverse, which use of the U-shaped renders possible, would have any useful effect; it may be that there are instances on record which demonstrate the contrary, but as the *primâ facie* assumption is the other way, such evidence should be very precise and clear to meet with acceptance.

Even if it be held proved that the roof of a building in a circular traverse is more likely to be injured by the concussion wave from the explosion of an adjacent building than the roof of a building enclosed with interrupted traverses, it would still be easy, by putting a strong yet light timber shield over the vats and inside the building, to protect the nitro-glycerine from the effects of such damage.

It is clear, from the effects of the recent explosion, that such a shield could be made quite light, and yet amply strong enough to resist the downward shock of concussion, or parts of the roof falling.

Under these circumstances, it would seem a mistake to abandon the circular form of traverse.

M. T. SALE, *Colonel,*
Superintendent, Building Works.

21*st May,* 1894.

APPENDIX X.

REPORTS of chemical examination, made by Dr. Dupré, of samples of the glycerine, sulphuric acid, and nitric acid, in use at Waltham Abbey, for the manufacture of nitro-glycerine at the time of the explosion of the 7th May, 1894.

29th May, 1894.

No. of sample.—1.

Name of material.—Glycerine (Waltham Abbey).

From whom received, and when.—Colonel McClintock, 15th May, 1894.

General result of examination.—Glycerine of very fair quality.

Details of sample and examination.—Sample contained in a small glass stoppered bottle, labelled "Glycerine. Sample of glycerine, duplicate of that used for the manufacture of nitro-glycerine on Monday, 7th May, 1894."

Pale amber coloured, clear, viscid liquid, having a specific gravity of 1·253, evolves no unpleasant smell when heated, and contained only a minute trace of free fatty acid. There are only traces of chlorides, sulphates, arsenic; no gums or sugar.

One part of the glycerine yields 2·02 parts of nitro-glycerine, which separates readily, and contains only minute traces of flocculent matter.

A. DUPRÉ.

29th May, 1894.

No. of sample.—2.

Name of material.—Sulphuric acid (Waltham Abbey).

From whom received, and when.—Colonel McClintock, 15th May, 1894.

General result of examination.—A very good sample of sulphuric acid.

Details of sample and examination.—Sample contained in small glass stoppered bottle, labelled "Sulphuric acid. Sample of sulphuric acid, duplicate of that used for the manufacture of nitro-glycerine on Monday, 7th May, 1894."

Nearly colourless oily liquid having a specific gravity of 1·845, and contains 96·27 per cent. monohydrate.

It is free from arsenic and other impurities.

A. DUPRÉ.

29th May, 1894.

No. of sample.—3.

Name of material.—Nitric acid (Waltham Abbey).

From whom received, and when.—Colonel McClintock, 15th May, 1894.

General result of examination.—The nitric acid is of proper strength, and contains rather less than the permitted maximum amount of nitrous acid.

It contains, however, rather stronger traces of chlorides and sulphates than the specification allows.

Details of sample and examination.—Sample contained in a small stoppered glass bottle, labelled "Nitric acid. Sample of nitric acid, duplicate of that used for the manufacture of nitro-glycerine on Monday, 7th May, 1894."

Orange coloured fuming liquid of 1·52 specific gravity. Stands the test for nitrous acid laid down in the specification, but contains rather more chlorides and sulphates than the specification allows, and leaves a trace of residue on evaporation.

A. DUPRÉ.

APPENDIX XI.

Drawings and Description of the Nitro-Glycerine Wash Tank in use at Waltham Abbey.

Wood tank narrowed at bottom.
Bound with four iron hoops, each 2 inches by $\frac{1}{4}$ inch.
The hoops covered, and the tank lined with lead.

The tank has a sloping bottom, with an outlet at its lowest point for nitro-glycerine. There is another outlet, 14 inches to one side and $3\frac{1}{2}$ inches from the bottom, for the washing water which is removed by the skimmer. This plays the part of a moveable cock, and is a shallow conical lead funnel $13\frac{1}{2}$ inches in diameter, connected by an indiarubber tube with the second outlet. The skimmer is suspended by a rope from a pulley, and is easily raised or lowered so as to be just below the surface of the washing water, and above that of the nitro-glycerine.

The washing is effected by agitating the nitro-glycerine with the washing water by means of compressed air. This is led into the tank by three lead pipes. The nitro-glycerine and washing water are brought from the nitrating house, and enter the tank at the top by a moveable pipe. There is a moveable lead screen fitted into the top of the tank to prevent splashing.

Internal dimensions.

	ft.	in.
Depth at outlet	2	$11\frac{1}{4}$
„ back	2	$8\frac{1}{2}$
Diameter at top	3	3
„ bottom	2	$11\frac{1}{2}$
Screen extends above top of tank	1	3
Diameter of skimmer	1	$1\frac{1}{2}$
Lead and indiarubber tube from skimmer to skimmer cock, about	3	0

F. L. NATHAN, *Captain, R.A.,*
Acting Superintendent, Royal Gunpowder Factory.

27*th June*, 1894.

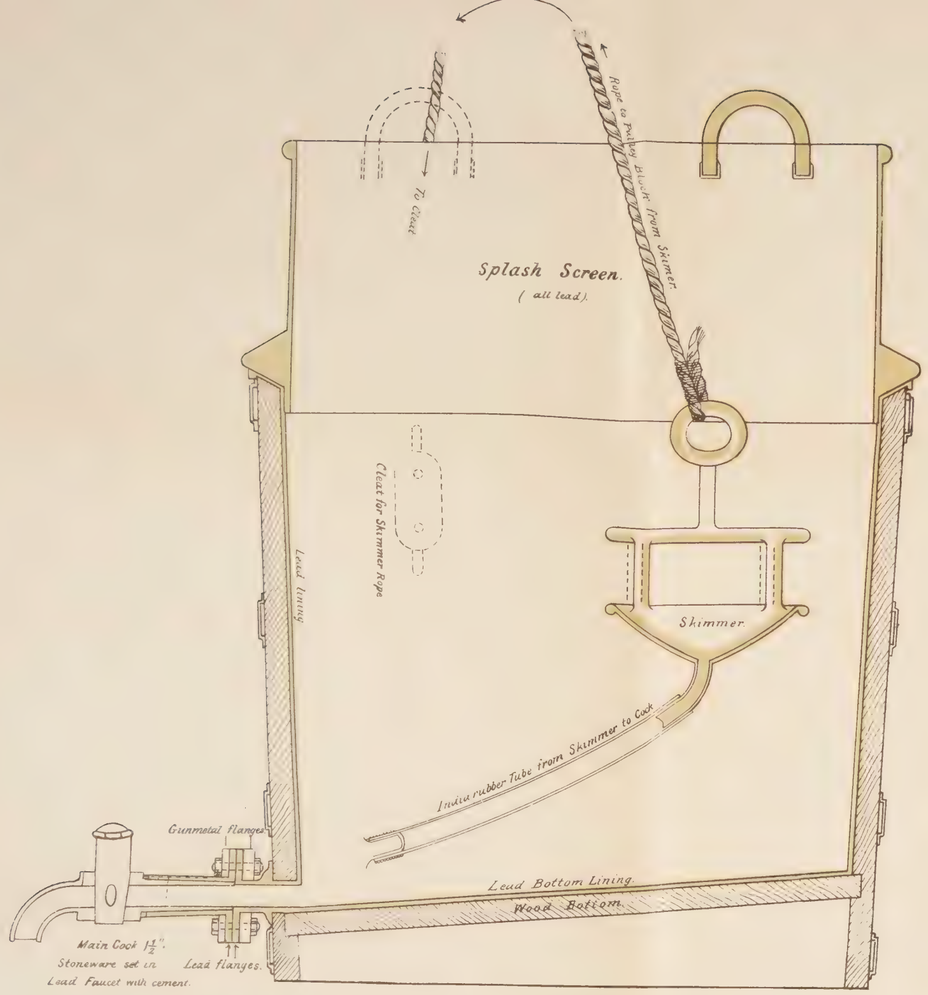
APPENDIX XII.

C.

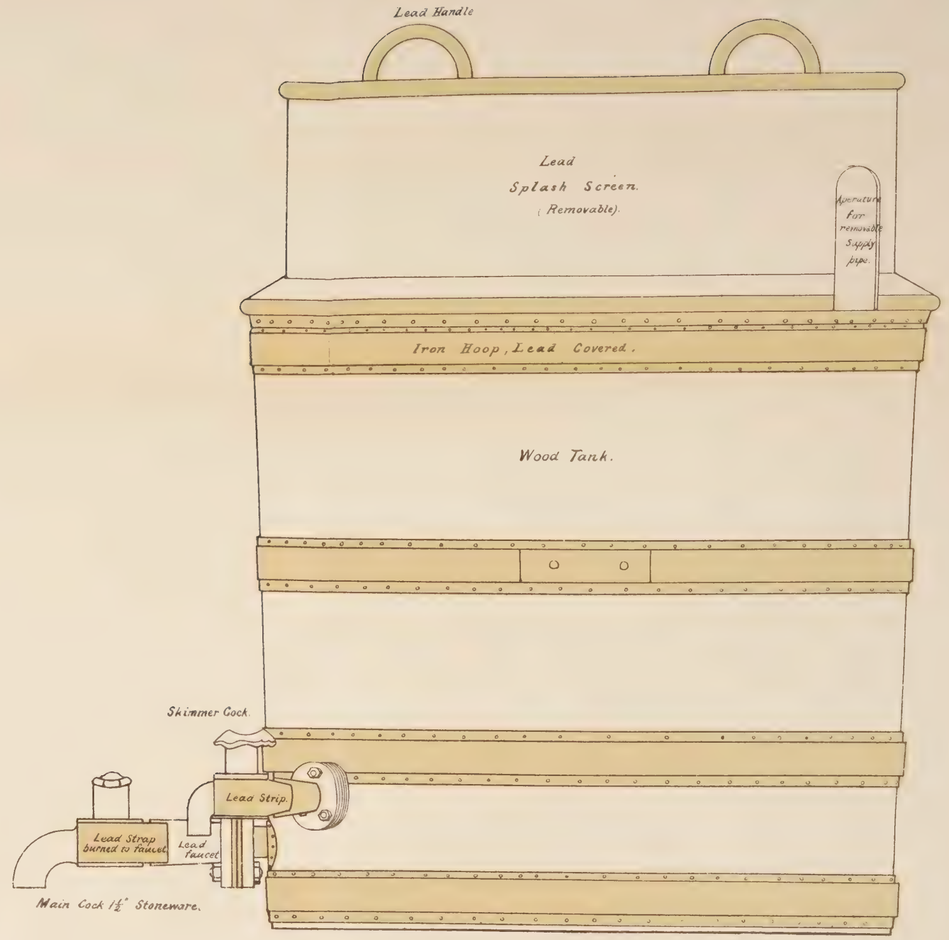
Letter (addressed to the Secretary) from Dr. Anderson, Director-General of Ordnance Factories, explaining certain modifications of the foregoing plans in A and B, and detailing other changes in the Factory to be carried out in connection with the reconstruction of the Nitro-glycerine Store and Washing House.

6th June, 1894.

In reply to your letter of the 5th instant, I have to inform you that on Monday the 4th instant I proceeded to Waltham Abbey with Colonel Sale and Dr. Kellner, and there discussed with Captain Nathan, the Acting Superintendent, Mr. Thomson, Chemist and Manager, and Captain Huleatt, R.E., the Resident Engineer, some of the details of the reconstruction of the nitro-glycerine factory.

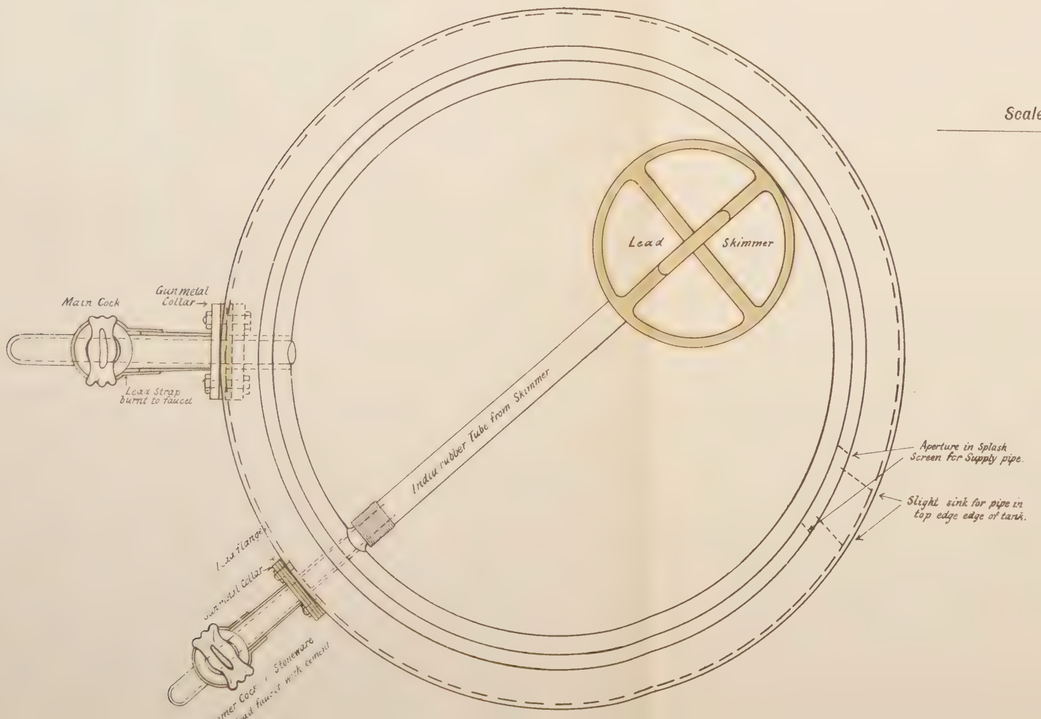


SECTION.



ELEVATION.

Scale, 6 inches = 1 foot.



PLAN AND DESCRIPTION OF NITRO-GLYCERINE WASHING TANK.

IN USE AT WALTHAM ABBEY.

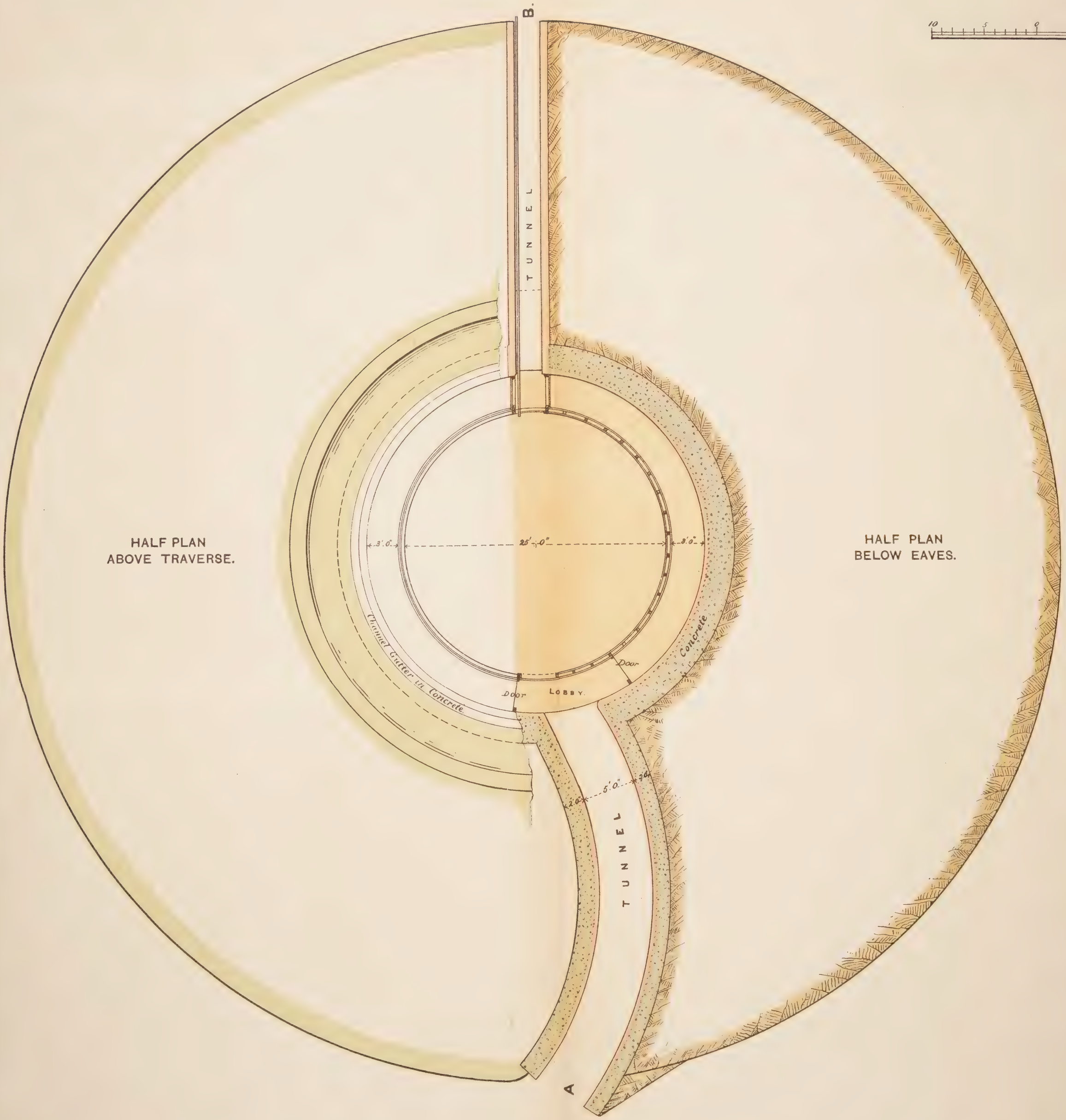
William Cotton
acty Superintendent R.G.F.
June 25th 1894

PLAN AND SECTIONS SHOWING THE RE-
WALT

(See Letter attached,

SCALE, 8

10 5 0



HALF PLAN
ABOVE TRAVERSE.

HALF PLAN
BELOW EAVES.

(7508/94 1229)[239 W.O]

Harrison & Sons

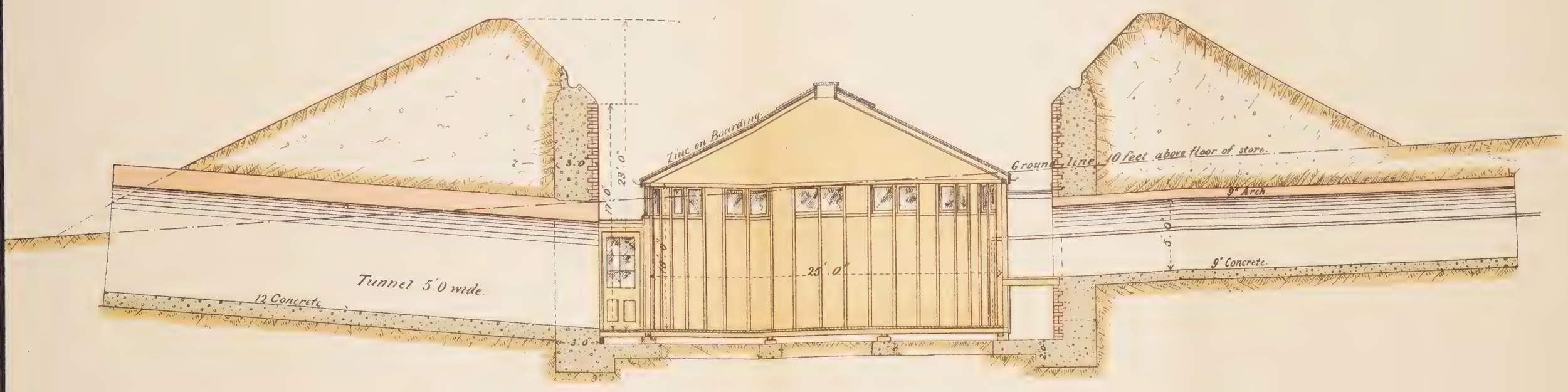
CONSTRUCTION OF THE NITRO-GLYCERINE STORE, HAM ABBEY.

A. (MAY, 1894.)

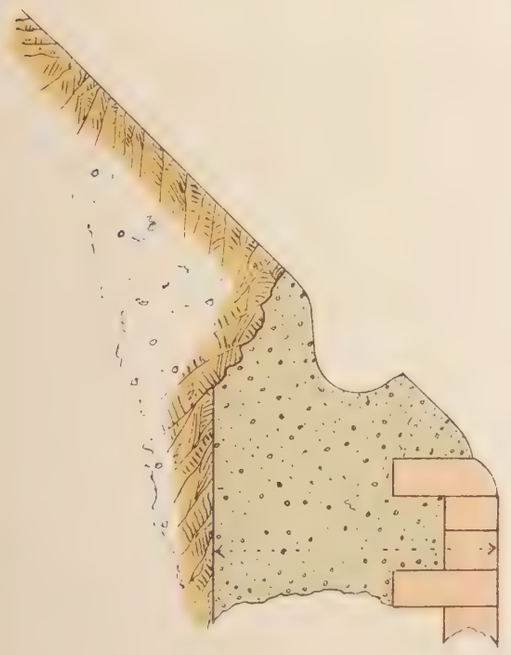
forming portion C. of this Appendix.)

FEET TO AN INCH.

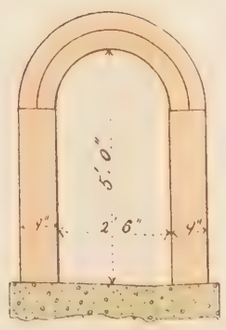
0 10 20 30 feet



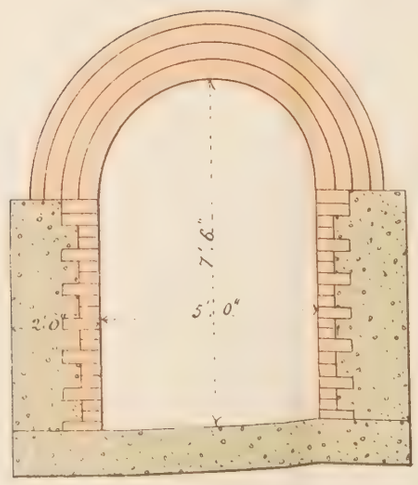
SECTION ON LINE A B.



SECTION OF TRAVERSE WALL.



SECTION OF TUNNEL TO WASH HOUSE.



SECTION OF TUNNEL TO ENTRANCE.

SECTION OF TRAVERSE WALL.

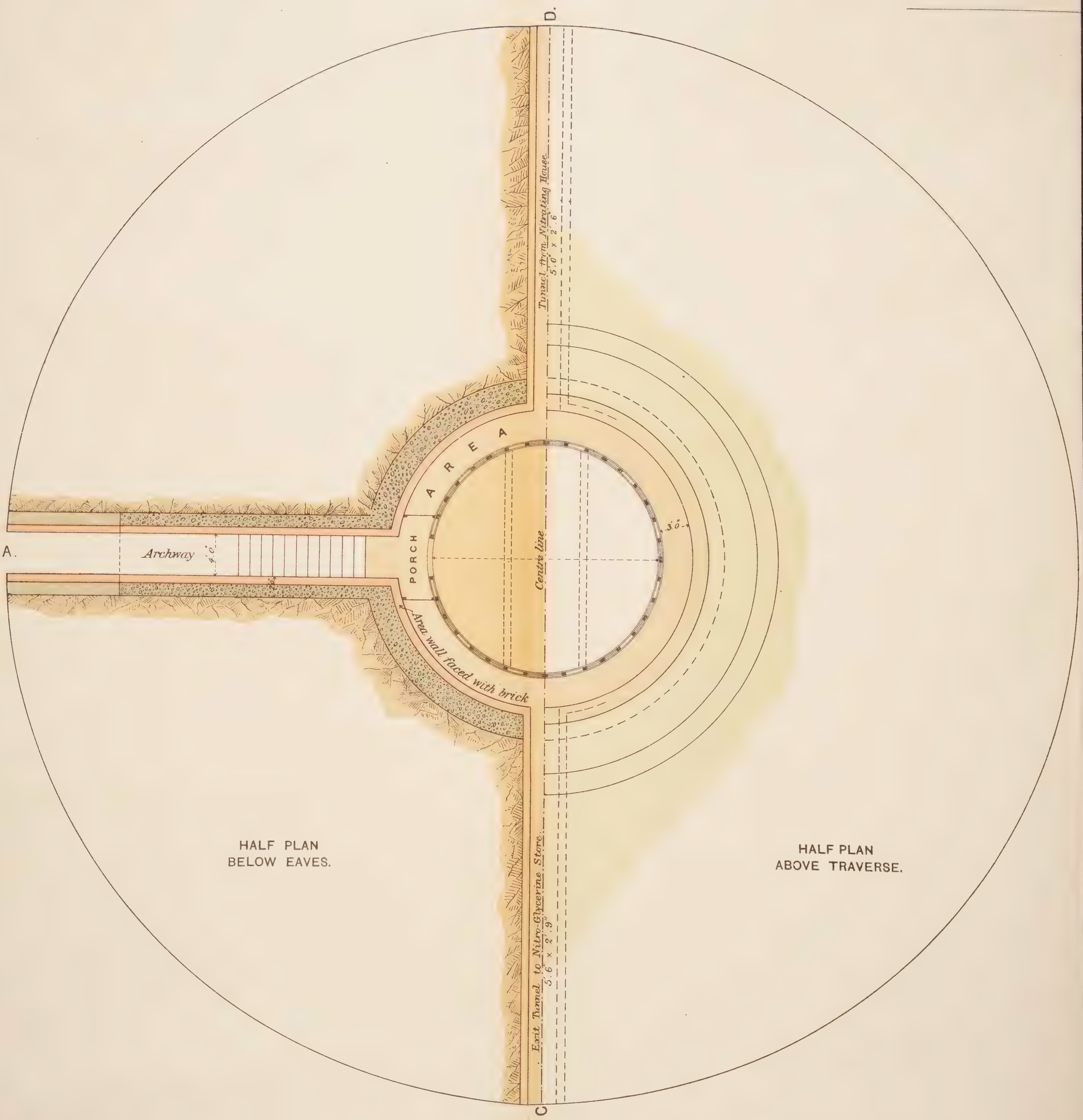
SCALE 4 FEET TO AN INCH.

0 1 2 3 4 5 6 7 8 9 10 20 Ft.

St. Martin's Lane W.C.

PLAN AND SECTIONS SHOWING THE RE-CONS
WALT

(See Letter attached)



SCALE

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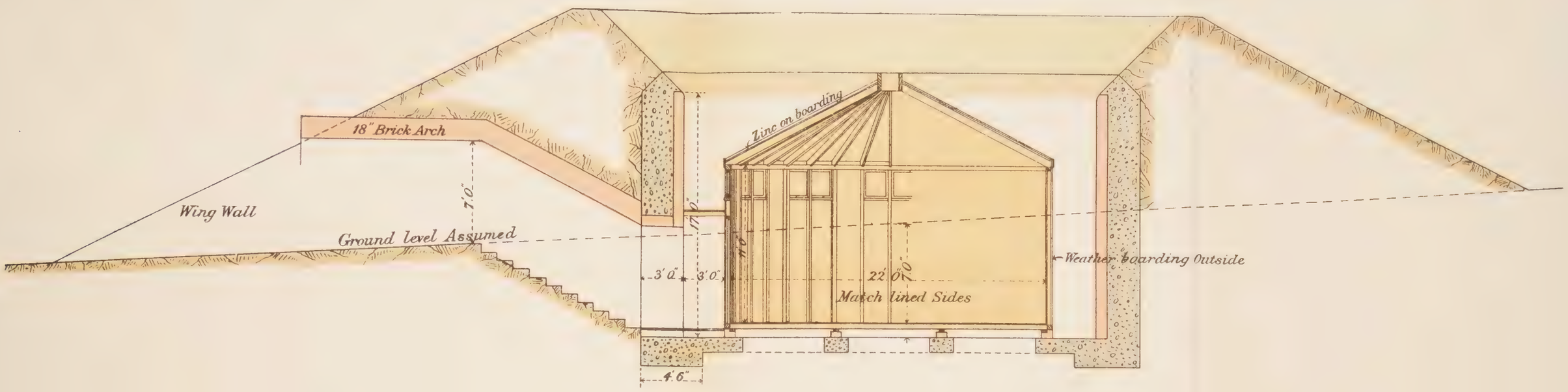
B. (MAY, 1894.)

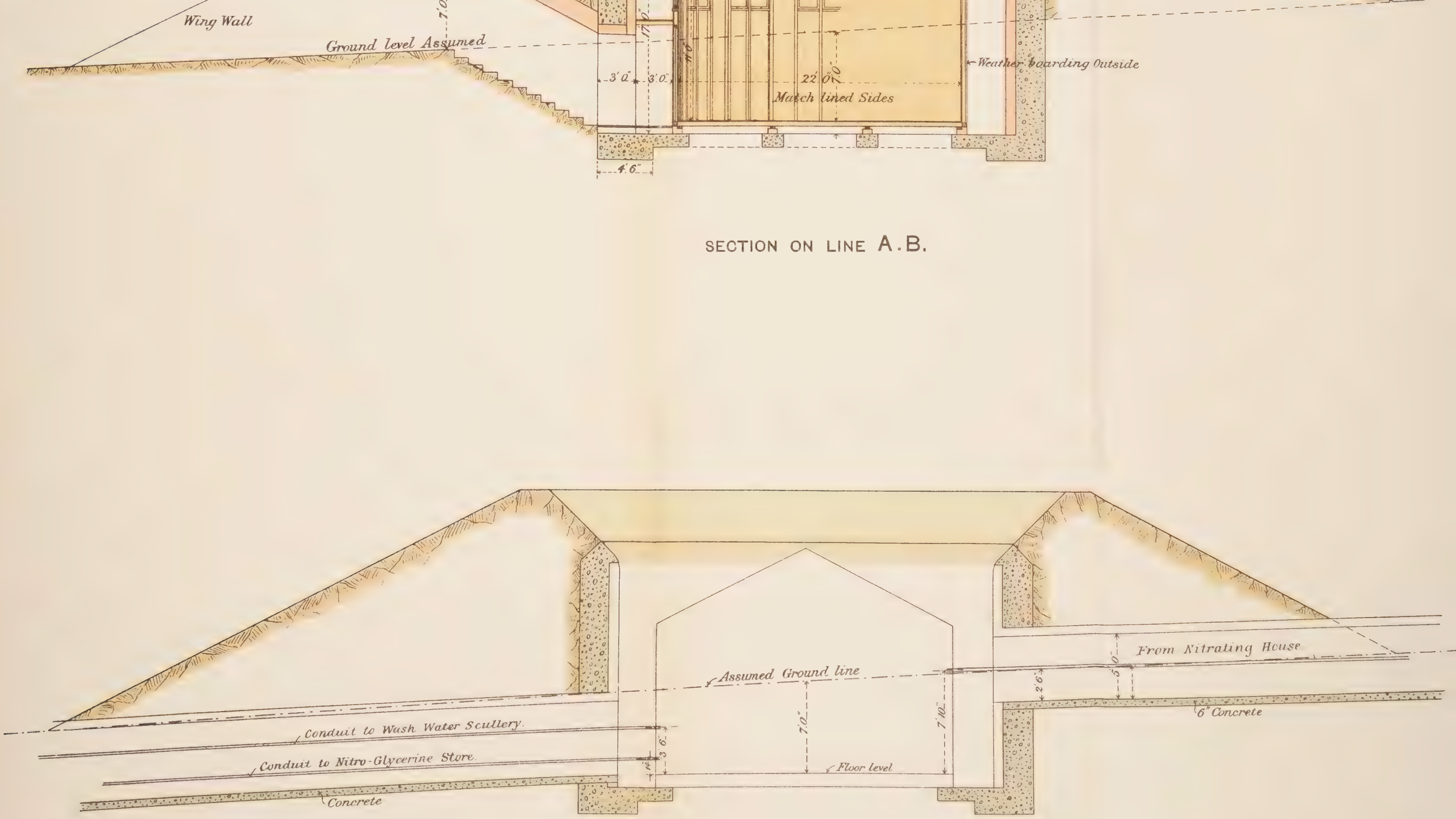
TRUCTION OF THE NITRO-GLYCERINE WASHING HOUSE, HAM ABBEY.

forming portion C. of this Appendix.)



SECTION ON LINE A.B.

B.



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FEET TO AN INCH.

ons Lith. St Martins Lane W.C

The plans of the washing house and nitro-glycerine store which I have marked, May, 1894, A and B, are substantially correct, but the following details have been settled:—

1. In the washhouse, B, the access will be by a tunnel ramped at a slope of 1 in 12, instead of the steps shown, and curved in plan like that of the store, A.

2. The floors of both the store and the washhouse are to be of concrete, covered with about 6 inches of fine sand.

3. The doors of both the store and the washhouse are to be rather larger than shown on the drawings.

4. That portion of the old traverse round the nitro-glycerine store which remains standing will be left as an addition to the circular traverse.

5. The existing No. 1 guncotton stove (*see* Appendix I.) will be converted into an alternative store, with a ramped approach and sand floor, and earth will be massed against the traverses as high as practicable.

6. The existing dry guncotton store (*see* Appendix I.) to be converted into a store for the first mixture of nitro-glycerine and guncotton. As there is now abundance of stove power for drying guncotton it is not proposed to have any store, but to use the guncotton direct from the stoves after they have cooled down.

7. The existing guncotton weighing house (*see* Appendix I.) to be removed, and a smaller weighing room to be erected near tray stove No. 2 (*see* Appendix I.).

8. The construction of the new tray stove to be suspended in view of its erection on the Lower Island.

9. A barbed-wire fence to be erected round the nitro-glycerine factory for the purpose of keeping people away from the buildings.

W. ANDERSON.

APPENDIX XIII.

NOTES as to the Waltham Abbey explosion handed to the Secretary by Mr. George McRoberts, supplementing the evidence given by the latter before the Committee on the 25th May.

Todhill, Newton-Mearns, Renfrewshire, N.B.,
8th June, 1894.

The first thing that struck me on hearing of this accident was that there had been some little oversight or carelessness on the part of the men in charge of the washing of the nitro-glycerine. The conditions under which nitro-glycerine will explode are well known, and are easily avoided, so that it seems impossible that any of the usual conditions under which an explosion is possible could exist in the washing of a charge.

It occurs to one to ask whether the tank in which the washing was done could be in good order; and even then it is difficult to conceive any possible set of circumstances under which, in the ordinary course of working, an explosion could take place. I assume that at Waltham Abbey every precaution was taken, by means of weekly inspections, to keep the plant (tanks, pipes, gutters, cocks, &c.) in thorough order and repair. At Ardeer I had established the plan of making no nitro-glycerine on Saturday, and on that day thoroughly inspecting, and, if necessary, repairing and testing every portion of the nitro-glycerine plant. The examination of the whole apparatus used for the production of nitro-glycerine was made by the foreman plumber, accompanied by the foreman nitro-glycerine

maker and the Superintendent Chemist of the Department, and was very thorough. Any defects discovered were at once made good by the plumbers' staff, so that work commenced on Monday morning with the utmost confidence on the part of the workmen that every portion of the plant in the nitro-glycerine department was as good as if it were new.

To that careful weekly inspection and upkeep of plant I attribute the immunity from accident in the nitro-glycerine department so long enjoyed at Ardeer. If that careful system, which Mr. Thomson had thoroughly learnt at Ardeer, were followed regularly at Waltham Abbey (and I do not doubt that it was), it is very difficult to assign a cause for the accident.

However, notwithstanding all the precautions and care taken to have everything in good order, it will sometimes happen that a cock will leak, or an air-pipe burst, or a water-pipe give way, during an operation. Such an accident need not be attended with danger if the men have their wits about them to put matters right. I have known a tank to leak during the washing of a charge; a bucket placed below so as to catch the leaking nitro-glycerine kept matters all right until the charge had been washed, when, of course, the tank was emptied and washed and taken out, and replaced by a fresh tank. I have known a new hand about to try to stop such a leak while the work was going on, when his foreman interfered to prevent any violent hammering of the lead while the charge was washing. To attempt to close a leak in a lead tank by hammering the lead while the nitro-glycerine was being washed in the tank would have been a very risky operation, and might have caused a serious disaster. The working rules with which the men of the nitro-glycerine department were fully equipped provided for accidents of that kind, and under them no repairs of any kind were allowed in a house, or in a tank, or in a gutter, when there was nitro-glycerine in it.

Now, in the absence of any evidence of what was taking place in the washing house just before the explosion, one is left to imagine one or other of the probable causes of explosion; and knowing that the apparatus was in good order, one is driven to the conclusion that the accident must have been caused by some little indiscretion in dealing with an emergency not specially provided for in the working rules, nor in the experience of the men. Such an emergency might be a leak, or the failure of a cock or air-pipe. None of those circumstances would be, *per se*, dangerous, provided the men knew how to deal with them, but if they did not, they might probably do something on the surprise of the moment that would produce the explosion. Such is the conclusion I have come to.

It has been suggested that the store tank, situated more than 60 yards distant from the washhouse, was exploded *sympathetically* by the explosion of the former. I cannot believe that. In all my experience I have never known a *sympathetic* explosion so-called; and I have seen many explosions, both intentional and accidental. The explosion of the store tank must have been caused by the destruction of the house, and the fall of the materials of the roof. It is easy to see how the explosion could occur under those circumstances, without the necessity of imagining anything of the nature of a sympathetic explosion.

In restoring the buildings destroyed, it will be necessary to consider whether better protection could be given to them by means of additional traverses or enlarged earthworks, the existing ones having been proved insufficient. It is not likely that such an accident as has just happened shall ever occur again; but whether or not, provision ought to be made in restoring the buildings for what additional protection can be obtained, whether by embankments or otherwise.

I understand that the store tanks contained 2 tons of nitro-glycerine. It may be wise to consider whether a smaller quantity would not be sufficient to keep in stock. There is no danger in the mere storing of nitro-glycerine which has been thoroughly purified, but nitro-glycerine is an expensive article to keep in stock; and considering the risks, 2 tons is a large quantity to store. It would be better to keep it in several buildings well separated from each other, than to keep it in one. If an explosion were to occur with the nitro-glycerine thus divided and protected, the consequences would be much less disastrous than was the case with the late explosion.

GEORGE McROBERTS.

APPENDIX XIV.

STATEMENTS of accidents in factories in the United Kingdom during the manufacture of nitro-glycerine, which have come under the notice of Her Majesty's Inspectors of Explosives since the Explosives Act, 1875, came into operation.

[NOTE.—The letters "A.R." signify Annual Report of Her Majesty's Inspectors of Explosives, and the figures immediately following those letters indicate the year of such report.
The letters "S.R." signify "Special Report."]

Date of accident.	Place where accident occurred.	Circumstances of accident.	Killed.	Injured.	References.
16.11.81	Factory 3, Ayr (Nobel's Explosives Company, Limited).	It was necessary to cut a trench to lay some gas-pipes. The trench had to pass close to a shed where all the mud, with nitro-glycerine in it, is washed, and to the pond whence all the wash water of the factory, after being as perfectly cleansed as possible, is run. The works manager had given directions that the trench should not be opened during his absence, but these instructions were disobeyed. The laying of the pipes proceeded satisfactorily until the pond was reached, when, after a lad who was employed had run one of the joints with lead, he deposited his lead pot, containing hot lead, in the trench, which was about 1 foot deep at the particular spot where some of the bags had lain which had contained sawdust which had been used to absorb nitro-glycerine recovered from a hulk used as a dynamite magazine which had been sunk in the Thames, and from which sawdust and bags all the nitro-glycerine that was possible had been subsequently washed out. No doubt some portion of the nitro-glycerine had not been removed and had leaked into the sand, and had become exploded by the hot lead pot.	..	1	A.R., 1881, pp. 35, 108; accident 108/1881.
8.6.82	Ditto	Accident probably caused by fall of a bottle or bottles of nitro-glycerine upon floor of sample magazine of factory. Fall most likely due to stumble or false step of foreman of nitro-glycerine department, who was carrying the bottles. Man and building blown to pieces.	1	..	A.R., 1882, pp. 35, 91. S.R., XLI., 29.6.82; accident 46/1882.
11.11.82	Factory 111, Carmarthen (Explosives Company, Limited).	Accident occurred in nitrating house No. 8, where the Boutmy system of making nitro-glycerine was being applied. The men had drawn off the larger portion of last-made charge of nitro-glycerine, and were absent in the washing house, whither they had removed the vessels containing the nitro-glycerine which had been drawn off. About 500 lbs. or 600 lbs. remained in nitrating tank. No one present in the building. Accident must have been due to tumultuous chemical action in the nitro-glycerine which had been exposed for a long time to contact with the acids, such accident being possibly caused by some slight exciting cause.	..	1	A.R., 1882, pp. 34, 105. S.R., XLVIII.; accident 116/1882.
9.7.85	Factory 3, Ayr (Nobel's Explosives Company, Limited).	The refuse acid tank (H^1), containing from 3 to 5 lbs. nitro-glycerine, exploded. The cause was, beyond doubt, spontaneous decomposition, occasioning heating of contents of the tank. No harm done beyond destruction of tank.	..	..	A.R., 1885, pp. 46, 147; accident 50/1885.
3.9.85	Ditto	Ditto	..	..	A.R., 1885, pp. 46, 152; accident 83/1885.

Date of accident.	Place where accident occurred.	Circumstances of accident.	Killed.	Injured.	References.
26. 6. 86	Factory 3, Ayr (Nobel's Explosives Company, Limited).	While plumber was engaged in repairing the bottom of the wash water tank No. 1 an explosion occurred, slightly injuring him. Accident due to unsuspected presence of nitro-glycerine which had leaked through leaden lining of tank on to the wooden bottom, coming in contact with heat of blowpipe, causing it to explode. Care is always taken to see if any leakage of nitro-glycerine has occurred, and this was done in the present instance.	..	1	A.R., 1886, pp. 32, 127; accident 70/1886.
21. 6. 88	Ditto	A plumber was cutting a lead gutter which had previously been used for running nitro-glycerine, and while cutting near a joint a minute quantity of nitro-glycerine, which had penetrated through a small leak in the metal, exploded. The gutter was torn open and distorted at the joint, the knife used by the man was broken, and his hand slightly bruised. The gutter had been washed in hot soda solution, and afterwards with hot water before it was operated on.	..	1	A.R., 1888, pp. 35, 127; accident 58/1888.
21. 2. 90	Factory 141, Cornwall (National Explosives Company, Limited).	Some nitro-glycerine in acid in the distributing vessel, which serves to distribute the refuse acids into the lead receivers for secondary separation, decomposed and exploded. No one was injured, the workmen having retired, but the walls of the building were partly thrown down, and the roof collapsed.	..	..	A.R., 1890, p. 118; accident 19/1890.
11. 2. 90	Factory 3, Ayr (Nobel's Explosives Company, Limited).	Decomposition of small quantity of nitro-glycerine in the nitrating apparatus. Cause not ascertained, but believed to have been due to presence of some foreign substance. In any case the decomposition was of an exceedingly local and partial character, but it was attended with an alarming evolution of red fumes, which drove the workmen from the house before they had opened the cock into the drowning house, and it was subsequently found that some of the nitrating apparatus had been melted by the heat evolved.	..	..	A.R., 1890, p. 120; accident 26/1890.
16. 4. 90	Ditto	Slight explosion of nitro-glycerine occurred in the shed where the waste acids are run for the purpose of recovery; it was probably due to the accidental presence of a few drops of the explosive lodging behind a cock in contact with acids more or less heated. The structural damage was slight. One man's face was slightly cut by grit flying about. The explosion occurred in a portion of the premises just outside the licensed area.	..	..	A.R., 1890, p. 124; accident 48/1890.
14. 5. 90	Factory 141, Cornwall (National Explosives Company, Limited).	Two buckets containing weak acid and a little nitro-glycerine, which had been drawn from the tanks of waste acid during the morning, were under orders to be removed from the place where they had been deposited, to the place authorized for deposition of refuse acid and secondary separation of nitro-glycerine. The order was not attended to, and the buckets were improperly placed outside a building where, it is assumed, the sun had full effect upon them. Some decomposition became established, and the contents of one bubbling over the wooden platform outside the building became ignited. The bucket was removed, and some drops of nitro-glycerine afterwards exploded on the platform.	..	..	A.R., 1890, p. 126; accident 58/1890.
4. 10. 90	Ditto	The explosion was undoubtedly due to the decomposition of an imperfectly purified sample of nitro-glycerine. There were also present in the building some few samples of dynamite and guncotton, amounting to about 8 or 10 lbs., which all exploded with the exception of about 2 lbs. of dynamite which was subsequently found among the débris. No one was injured, and the damage done was confined to the building, which was totally destroyed, the surrounding mounds affording very efficient protection.	..	..	A.R., 1890, p. 134; accident 93/1890.

Date of accident.	Place where accident occurred.	Circumstances of accident.	Killed.	Injured.	References.
10. 6. 91	Factory 141, Cornwall (The National Explosives Company, Limited).	One of the separating vessels decomposed very suddenly with a "high flame," destroying the vessel and part of the cooling worm; it also tore open the wood lining of the building, opened the north-east and west walls, broke some of the roof supports, and damaged the show glasses and thermometers. The cause is attributed to the sudden decomposition of the waste acid.	..	1	A.R., 1891, p. 115; accident 50/1891.
30. 8. 91	Factory 3, Ayr (Nobel's Explosives Company, Limited).	A slight local heating took place in a secondary separator, causing the evolution of red fumes. On the air being turned on the action was checked in about 2 minutes. No harm was done beyond the cracking of a glass cylinder by the heat. It has not been possible to assign with confidence a cause for the accident, but it is suggested that it may have been due either to the fact— (1.) That a drop of nitro-glycerine may have begun to decompose on or under the surface of the acid, although no nitro-glycerine was visible under it when the workman examined it; or (2.) That some foreign body may have entered the separator, and been caught against the lead near the glass.	..	..	A.R., 1891, pp. 30, 121; accident 85/1891.
11. 10. 91	Factory 7, Kent (Cotton Powder Company, Limited).	A batch of nitro-glycerine fumed off in the separating tank in No. 103. The man who was present had orders, if fumes arose, to turn the air on and draw the plug and run away, but he only observed the latter part of his instructions. Some of the mixture of nitro-glycerine boiled over and ran into the "montejus," and eventually exploded, injuring the "montejus." The damage done to the building was very slight. The "montejus" was destroyed.	..	..	A.R., 1891, p. 123; accident 102/1891.
24. 10. 91	Ditto	The explosion of a small quantity of nitro-glycerine occurred in a pipe leading from building No. 103 to a vessel placed on the top of a mound surrounding No. 103. It appears that after the accident of 11.10.91 (No. 102, 1891), the pipe above-mentioned became bent, and cut off from the compressed-air pipe, by which it was usually cleansed, and there is no doubt that a small quantity of acid containing some nitro-glycerine had remained in the bend of the pipe, where spontaneous decomposition became established, which eventuated in an explosion. The fumes had been observed coming from the pipes for some hours before. No damage was done, and no one injured.	..	..	A.R., 1891, p. 124; accident 108/1891.
18. 12. 91	Factory 141, Cornwall (The National Explosives Company, Limited).	A slight explosion occurred in one of the secondary separators, into which waste acids are run. The lead cover was raised, but not thrown off. No one was injured, nor was any damage done beyond the ejection of acid on to the adjoining woodwork. The "bottle" was not quite full.	..	..	A.R., 1891, p. 128; accident 132/1891.
20. 9. 92	Factory 148, Cornwall (British and Colonial Explosives Company, Limited).	A flannel filter bag, used in the first mixing house to filter nitro-glycerine, having been washed, was hung on a chair before the fire in the nightwatchman's mess house (instead of drying in the open air). It exploded the following morning without any personal injury. The only damage done was a pane of glass broken. The bringing of the bag out of the danger area, where it should have been allowed to dry naturally was contrary to the company's orders.	..	..	A.R., 1892, p. 150; accident 102/1892.
2. 5. 93	Factory 3, Ayr (Nobel's Explosives Company, Limited).	One of the chemists was examining a small sample of nitro-glycerine in the laboratory of the factory when it exploded, and his face and hands were cut with the glass of the bottle in which it was contained. The damage to the laboratory was trifling, consisting chiefly of broken windows.	..	1	A.R., 1893, p. 142; accident 32/1893.

Date of accident.	Place where accident occurred.	Circumstances of accident.	Killed.	Injured.	Reference.
5. 9. 93	Factory 148, Cornwall (British and Colonial Explosives Company, Limited).	The explosion occurred in the bottom of the nitrating vat in "A" house. The vat had been used that morning for one nitration, and the accident was caused by the accumulation of scale which retained a proportion of acids with nitro-glycerine. Decomposition is believed to have set in. It was estimated that not more than 1 oz. of nitro-glycerine was present at the time. No one was injured, and the damage consisted in the bottom edge of the vat having a hole made in it about a foot in length. One of the standards of the outside coils was much bent, the wooden laggings of the casing of the vat displaced, the cover of the vat lifted and bent, while the acid inlet and earthenware tap, the glass in the vat cover, and four or five windows were broken. The house itself was uninjured, and the charge of glycerine for the following day's work intact in the tank. The effects were such as might have been caused by about an ounce of nitro-glycerine. The explosion was undoubtedly due to the retention of acid and nitro-glycerine by scale at the bottom of the vat.	..	..	A.R., 1893, pp. 31, 148; accident 69/1893.

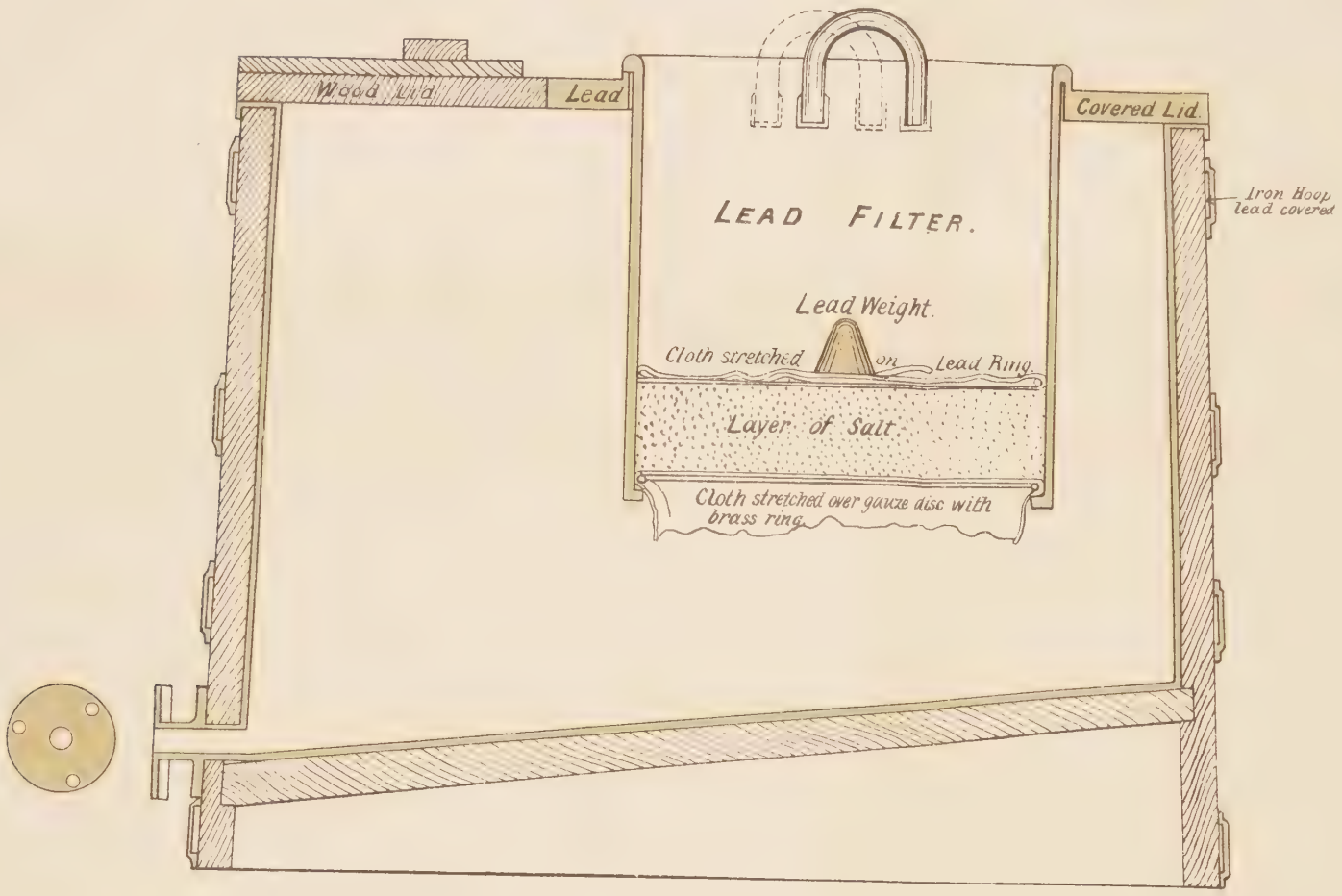
APPENDIX XV.

RETURN showing accidents in foreign factories during the manufacture of nitro-glycerine which have come under the actual notice of Her Majesty's Inspectors of Explosives.

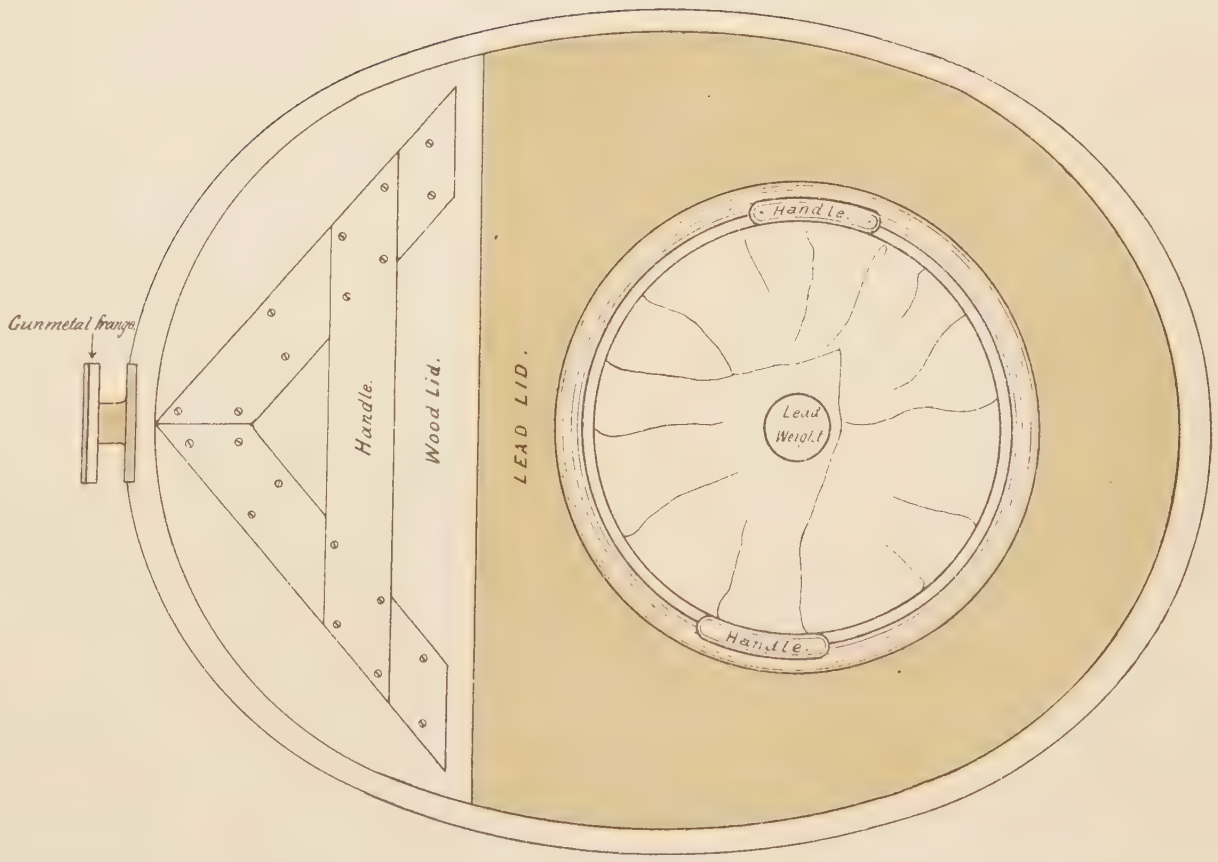
[NOTE.—The letters "A.R." signify Annual Report of Her Majesty's Inspectors of Explosives, and the figures immediately following those letters indicate the year of such report.]

Date.	Place.	Particulars.	Killed.	Injured.	Reference.
6. 11. 76	Vonges Factory, France.	An explosion in a carboy containing acids and nitro-glycerine in process of separation.	..	..	A.R., 1887, p. 53.
5. 7. 84	Schlebusch (Hamburg Dynamite Company).	Accident probably due to the men in washing house opening the wrong tap, and so letting the waste water flow into the first separator, instead of into a safe vessel.	..	..	A.R., 1884, pp. 45, 46.
20. 10. 84	Factory at Kororoit Creek, near Melbourne.	A similar accident to above	..	..	A.R., 1884, p. 46.
15. 4. 85	Matagne le Grand Factory.	An explosion in a carboy containing acids and nitro-glycerine in process of separation.	..	..	A.R., 1887, p. 53.
22. 7. 85	Kalk Factory, near Cologne.	Explosion in nitrating house, due to a flaw in one of the cooling tubes, caused by a previous explosion.	..	..	A.R., 1885, pp. 62, 63.
5. 86	California Powder Works, near San Francisco.	Explosion in washing nitro-glycerine. of bably caused by the fall of a bucket nitro-glycerine, which a man was carrying.	5	..	A.R., 1886, p. 46.
11. 8. 87	Giant Powder Works, near San Francisco.	Explosion in separating and washing house, due to use of impure glycerine.	1	Several	A.R. 1887, p. 51.
1888	Ardley, U.S.A. ..	Explosion of nitro-glycerine in a bucket, possibly caused by the stumbling of the man carrying it.	2	..	A.R., 1888, p. 50.

PLAN AND DESCRIPTION OF NITRO-GLYCERINE FILTER TANK IN USE AT WALTHAM ABBEY.



SECTION.



PLAN

Wood

Lead

Scale, 6 inches = 1 foot.

Waltham Cross
Asst Superintendent R.S.P.F.
22/6/94

50.8/94 1251)[239 W.O]

Harrison & Sons Lith. St Martins Lane W.C.

Date.	Place.	Particulars.	Killed.	Injured.	Reference.
19. 5. 89	Arendonck Factory ..	Explosion in draining basin for water used in washing. Water evaporated, and the nitro-glycerine residue was exploded by solar rays.	..	..	A.R., 1889, p. 50.
3. 6. 91	Schlebusch Factory ..	Explosion of nitrating, washing, and mixing houses, struck by lightning.	3	..	A.R., 1891, p. 48.
22. 12. 91	Krummel Factory, near Hamburg.	Explosion in opening the refuse acid conduits, which were stopped up by frozen nitro-glycerine and acid.	8	..	A.R., 1891, p. 48.
9. 7. 92	Giant Powder Works, California.	Nearly destroyed by a series of explosions, which originated in the nitrating and washing house.	5	Over 20	A.R., 1892, pp. 44, 45.
13. 7. 92	Schlebusch Factory ..	Washing house again struck by lightning ..	..	..	A.R., 1892, p. 48.
25. 7. 93	Ablon Factory, near Honfleur.	Nitrating, filtering, and incorporating houses destroyed. Possibly caused by earthenware taps in filtering room.	..	..	A.R., 1893, pp. 51, 52.

APPENDIX XVI.

Nitro-Glycerine Filter Tank.

Wood tank narrowed at top.

Bound with four iron hoops, each 2 inches by $\frac{1}{4}$ inch.

The hoops are covered with lead, and the tank lined with lead.

The lid is in two parts, one wood and the other covered with lead.

The lead-covered lid has a hole in it of 18 inches diameter, in which the filter proper is hung. This consists of a lead cylinder with handles, open at top and bottom. The bottom has an internal rim, which supports a brass ring with a disc of gauze soldered on it. This disc is covered with a cloth. Above the cloth is a layer of salt, covered with another cloth stretched over a lead ring. The ends of the lower cloth hang into the tank, those of the upper cloth are weighted down.

The tank has a sloping bottom, with an outlet at its lowest point.

The nitro-glycerine is run into the filter at the top by a lead elbow, which connects the filter with the washing tank. The nitro-glycerine is drawn off from a cock at the bottom of the washing tank.

The internal dimensions of the tank are—

	ft.	in.
Depth at outlet	2	$4\frac{1}{4}$
„ back	2	$0\frac{1}{4}$
Diameters at top	3	$2\frac{1}{2}$
„ „	2	$4\frac{1}{2}$
„ at bottom	3	$4\frac{1}{2}$
„ „	2	$5\frac{3}{4}$

The dimensions of the filter are—

	in.
Depth	$18\frac{1}{4}$
Diameter	18

F. L. NATHAN, *Captain, R.A.*,
Acting Superintendent, Royal Gunpowder Factory.

22*nd June*, 1894.

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